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31 March 1964

COLLINS

interim development report

Progress Report for GSFC Four Stations 1 March to 31 March 1964

Prepared for Goddard Space Flight Center
Contract NAS 5-2462

[redacted]

Dallas Division | Collins Radio Company, Dallas, Texas
Printed in U. S. A.

SPACE SYSTEMS AND ANTENNA DIVISION

Approved:

B. A. Sustare	G. F. Mansur
Contract Administration	Project Director

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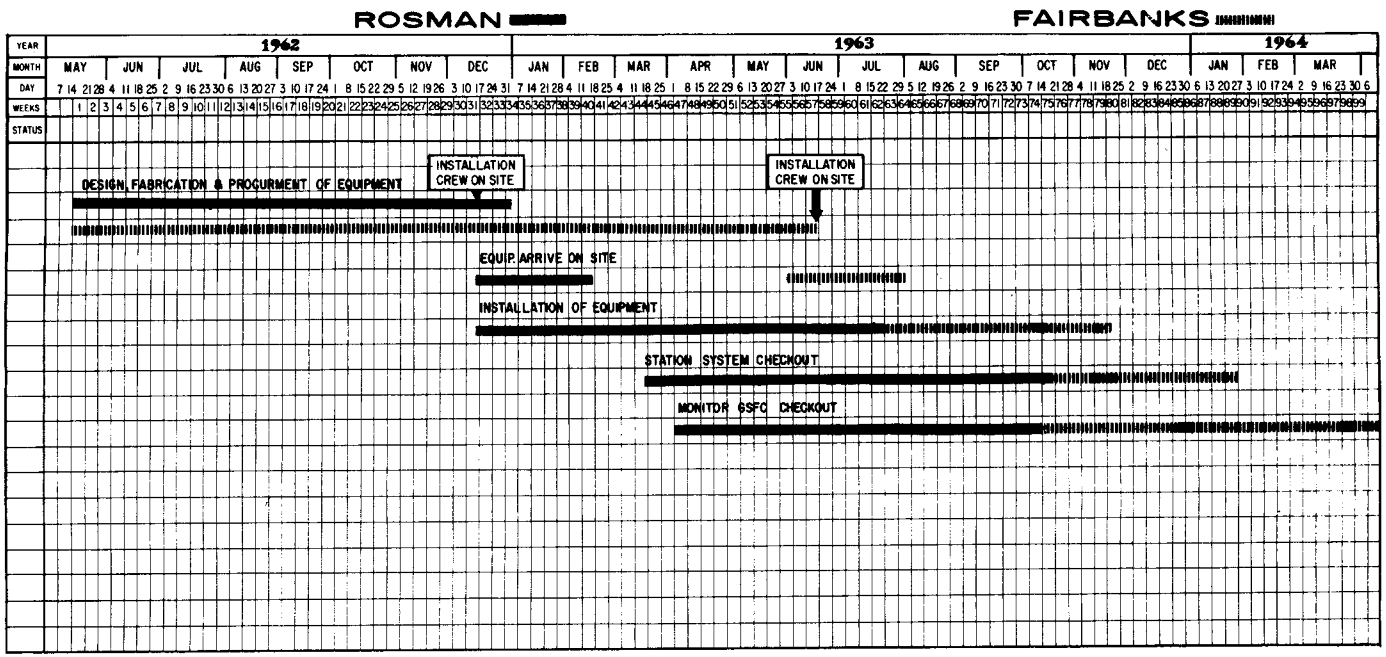
MILESTONE SCHEDULE

GSFC FOUR STATION

INSTALLATION PROGRESS ·



section 1

general

This is the twenty-first in a series of monthly reports covering progress under contract NAS 5-2462.

At the close of the period the Gilmore installation was complete except for minor hydraulic modification and replacement of TRW switches in the 400-mc feed system. The installation crew at Gilmore had been reduced to one hydraulic engineer.

The Gilmore station has been accepted by NASA except for the 136-mc feeds and 136-mc receiver system.

Hydraulic problems continued at Rosman and, at the end of the period, an engineer from Collins and from Vickers remained on site. Complete information on this matter is contained in section 7.

MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM R-F ENGINEERING

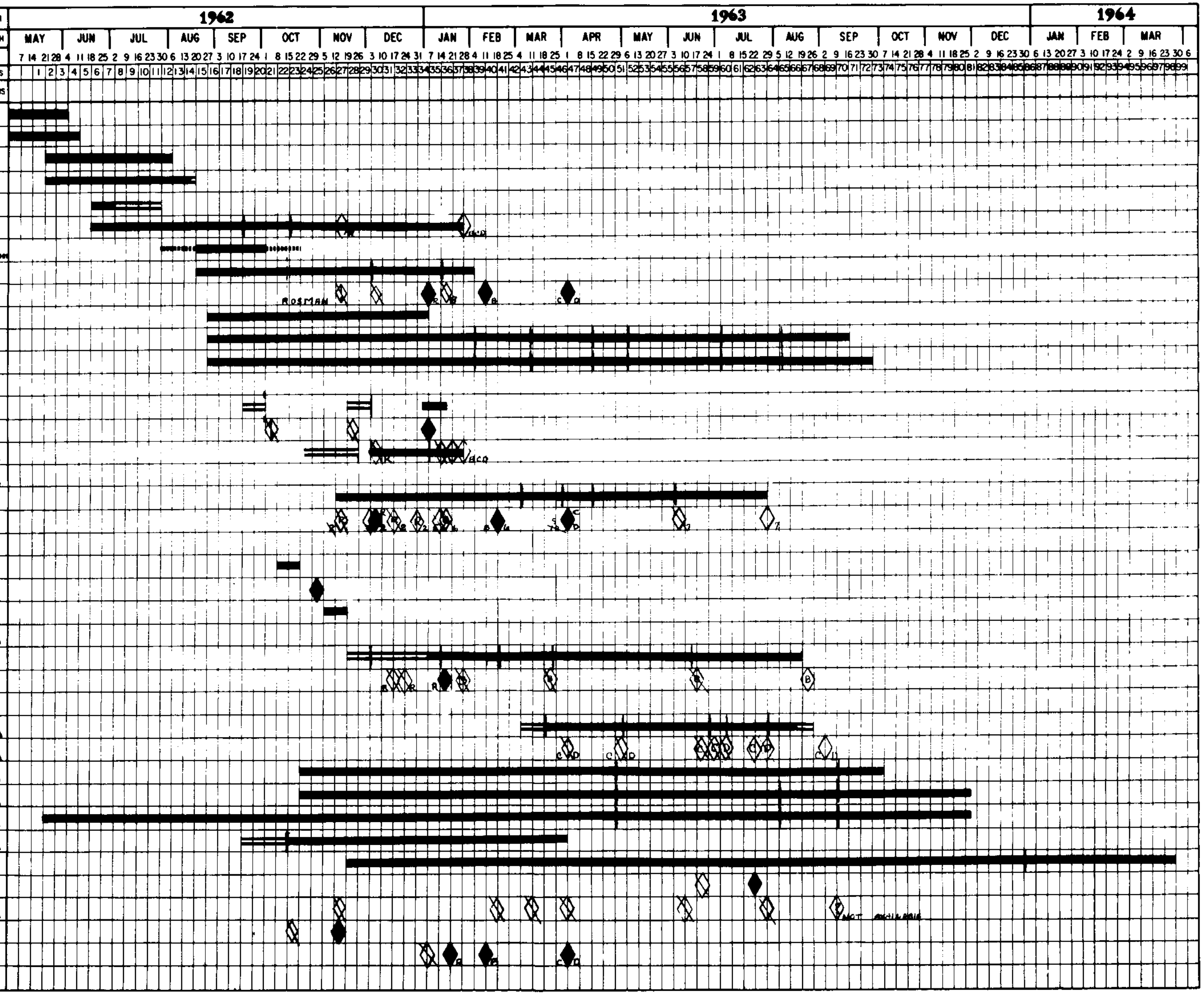
SUPPLIER COLLINS AND . . .

NOISE FIGURE MFA. SYS - HEWLETT-PACKARD
PARAMETRIC AMP/CON - AIL
SPECIAL PURPOSE T/M RCVR. - DEI
MULTICOUPLER - ITT

A. MAKTAS
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1.	EQUIPMENT LIST	▲
2.	FINAL SPECIFICATION	▲
3.	PURCHASE ORDERS ACCEPTED	▲
4.	DESIGN COLLINS - BUILT EQUIPMENT	▲
5.	DESIGN APPROVAL FOR SUBS.	▲
6.	FAB & ASSEM. COLLINS-BUILT EQUIP.	▲
	~~[illegible]~~	
8.	TEST COLLINS - BUILT EQUIPMENT	▲
9.	DELIVER COLLINS - BUILT EQUIPMENT	▲
10.	APPROVE TEST PROCEDURES	▲
11.	PRELIMINARY INSTRUCTION MANUALS	▲
12.	SPARE PARTS LIST	▲
13.	NOISE FIGURE MEASUREMENT EQUIPMENT	▲
	a. ACCEPTANCE TEST	▲
	b. DELIVER TO COLLINS	▲
	c. INTEGRATION WITH COLLINS BUILT EQUIPMENT	▲
14.	130 MC MULTICOUPLER	▲
	a. ACCEPTANCE TEST	▲
	b. DELIVERY (20 UNITS)	▲
15.	SPECIAL PURPOSE TELEMETRY RECEIVERS	▲
	a. ACCEPTANCE TEST	▲
	b. DELIVER TO COLLINS	▲
	c. INTEGRATION w/COLLINS BUILT EQUIP	▲
16.	400 MC PARAMP/CONVERTER	▲
	a. ACCEPTANCE TEST	▲
	b. DELIVER TO SITE	▲
17.	1700 MC PARAMP/CONVERTER	▲
	a. ACCEPTANCE TEST	▲
	b. DELIVER TO SITE	▲
18.	FINAL INSTRUCTION MANUALS	▲
19.	FINAL REPORTS	▲
20.	MONITOR SUBCONTRACTOR EFFORT	▲
21.	TRAIN INSTALLATION PERSONNEL	▲
22.	ENGINEERING BACKUP FOR INSTALL.	▲
23.	SPARE PARTS PLACED ON ORDER	▲
24.	DELIVER PHASE LOCK DEMODULATOR (GFE) TO COLLINS	▲
25.	DELIVER 136 MC PREAMP (GFE) TO ITT FOR TEST	▲
26.	COLLINS/PURCHASED EQUIPMENT DELIVERED TO SITE	▲



section 2

r-f engineering

2.1 GENERAL.

It is the purpose of this section to briefly discuss the ground reflection conditions at the Fairbanks II installation.

2.2 GROUND REFLECTION ANALYSIS.

Figure 2-1 shows an approximation to the terrain cross section for the range, using the near collimation tower. From this figure it can be seen that a low grazing angle is present, due to the shortness of the tower. In addition, there is a small hill approximately 200 feet from the tower which causes a knife edge diffraction effect. Both of these conditions can cause variations in field strength across the face of the dish. The variations due to knife edge diffraction were determined to be only 0.6 db using the Cornu Spiral technique. Thus, diffraction effects are negligible. The ground reflections are quite severe, however, and their effects can be approximated as follows:

From the simplified geometry shown in figure 2-2, it is apparent that the grazing angle of the reflected energy is given by

$$\theta = \mathrm{Tan}^{-1} \frac{h_1 + h_2}{d}$$

$$= \mathrm{Tan}^{-1} \frac{100}{2500} = {}^{-1}(0.04)$$

$$\theta = 2.3°$$

where h_1 = height of test antenna = 50 feet and h_2 = height of source antenna = 50 feet (taken from scale drawing in figure 2-1).

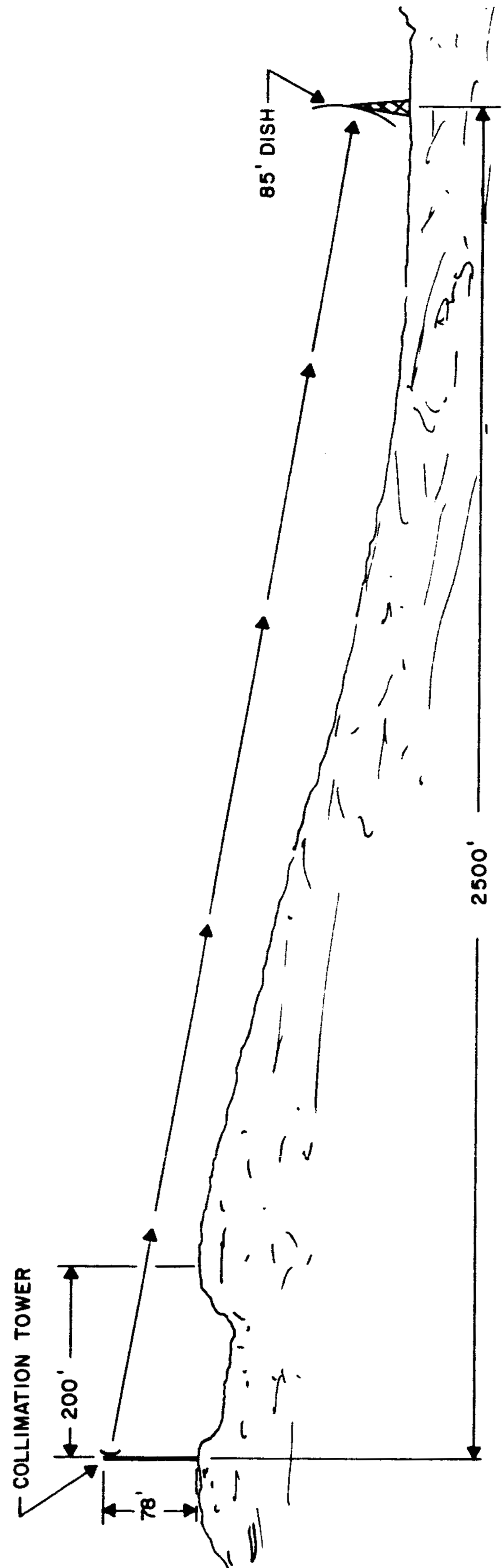


Figure 2-1. Terrain Cross Section for Near Collimation Range at Fairbanks II

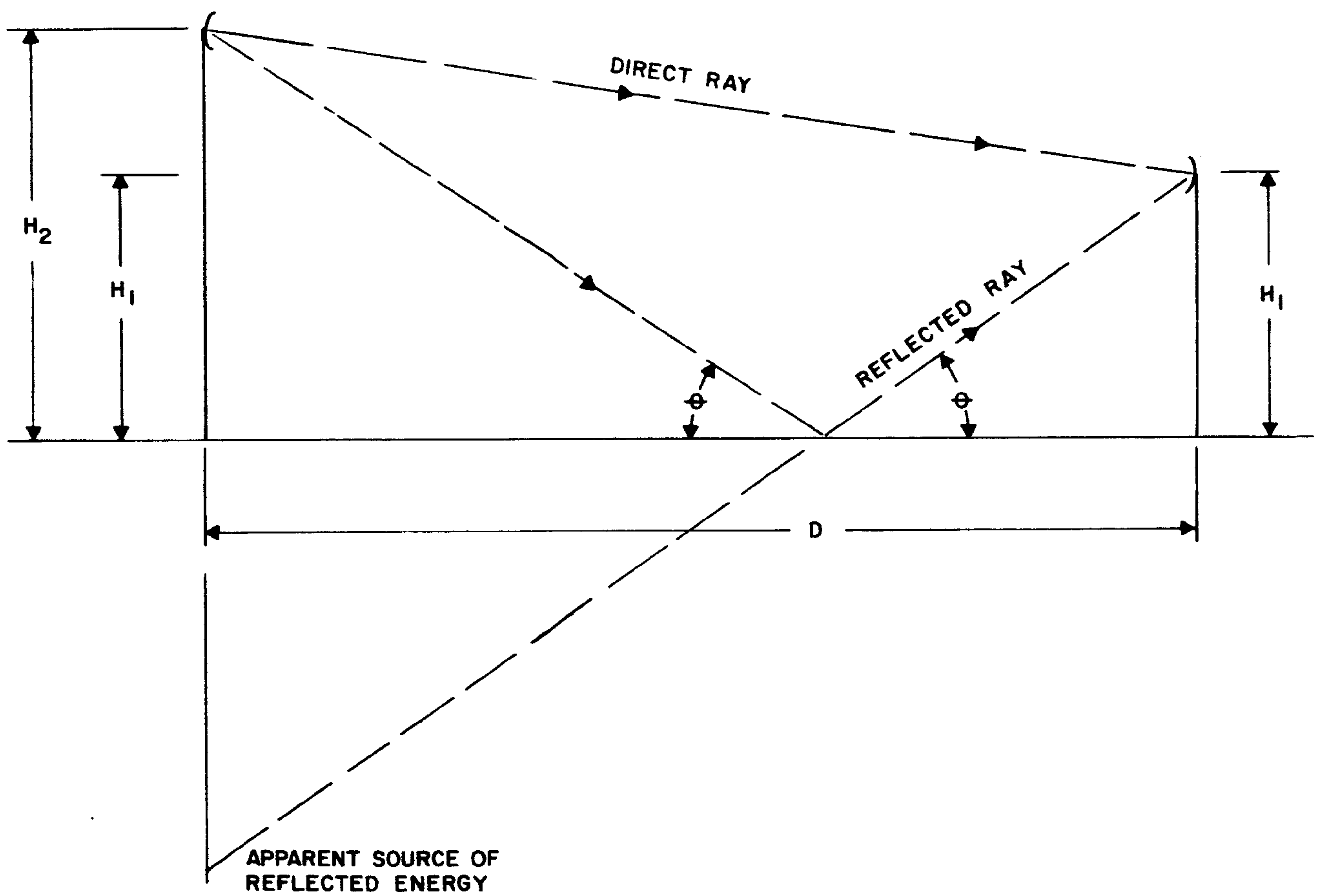


Figure 2-2. Simplified Range Geometry

The reflection coefficient, R, may be determined from the curves in figure 2-3.* Although these curves are for 100 mc, they may be used with little error at 136 mc, since the ground reflection characteristics change quite slowly with frequency. Using average land, the reflection coefficient for vertical polarizations is 0.7 while that for horizontal polarization is 0.975. The maximum and minimum field strengths at the 85-foot antenna are

$$E_{max} = E \text{ direct} + E \text{ reflected}$$

$$E_{min} = E \text{ direct} - E \text{ reflected}$$

with E_d assumed to be unity (for reference). The variation in field strength for vertical polarization in decibels is given by

$$20 \log \frac{E_d + E_r}{E_d - E_R} = 20 \log \frac{1.0 + 0.7}{1.0 - 0.7} = 15 \text{ db}$$

For horizontal polarization this variation becomes

$$20 \log \frac{1.975}{0.025} \quad \text{or} \quad 38 \text{ db.}$$

The vertical distance between nulls at the 85-foot antenna can be calculated as follows. For the geometry in figure 2-2, let

1_1 = path length of direct ray and

1_2 = path length of reflected ray.

then $1_1 = \sqrt{d^2 + (h_2 - h_1)^2}$

and $1_2 = \sqrt{d^2 + (h_2 + h_1)^2}$

let Δ = path difference $= 1_2 - 1_1$

$$= \sqrt{d^2 + (h2 + h1)^2} - \sqrt{d^2 + (h2 - h1)^2}$$

for $d \geqq 10 (h_1 + h_2)$ the first two terms of the binomial expansion will give a good approximation of ℓ.

* Ultra High Frequency Propagation, Reed & Russell, p. 95

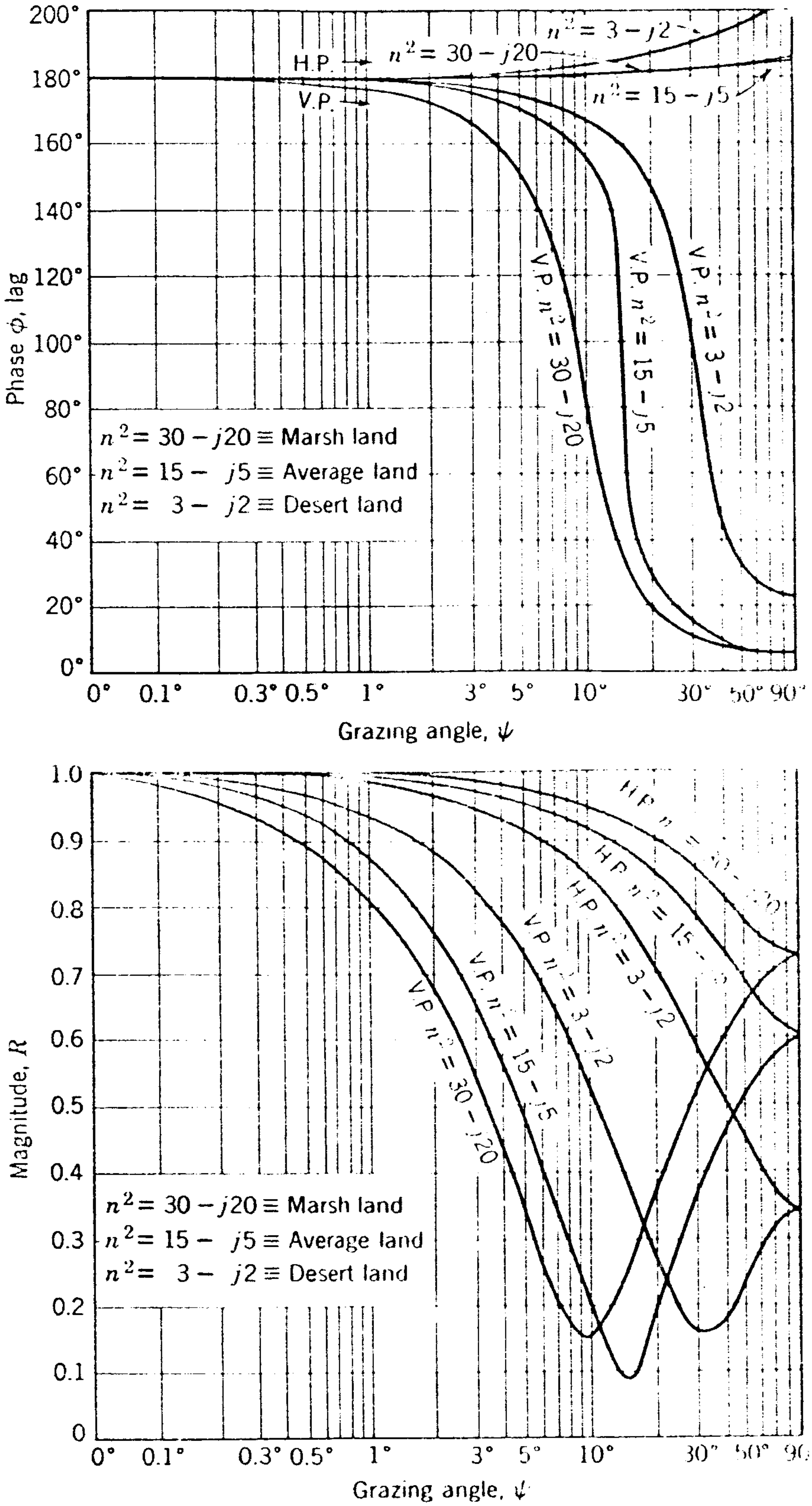


Figure 2-3. Magnitude R and Phase ∅ of Reflection Coefficient vs. Grazing Angle ψ for Smooth Land (Frequency: 100 mc)

Thus,

$$\Delta = d + \frac{1/2\ (h_2 + h_1)^2}{d} - d - 1/2\frac{(h_2 - h_1)^2}{d}$$

$$= \frac{2\,h_1\ h_2}{d}$$

If the source is moved to some new height h_2', $(h_2' < h_2)$, the new path length difference is $\Delta' = 2\,\frac{h_1\ h_2'}{d}$

The change in path length δ then can be defined as

$$\delta = \Delta - \Delta' = \frac{2h_1}{d}\ (h_2 - h_2')$$

Rearranging gives:

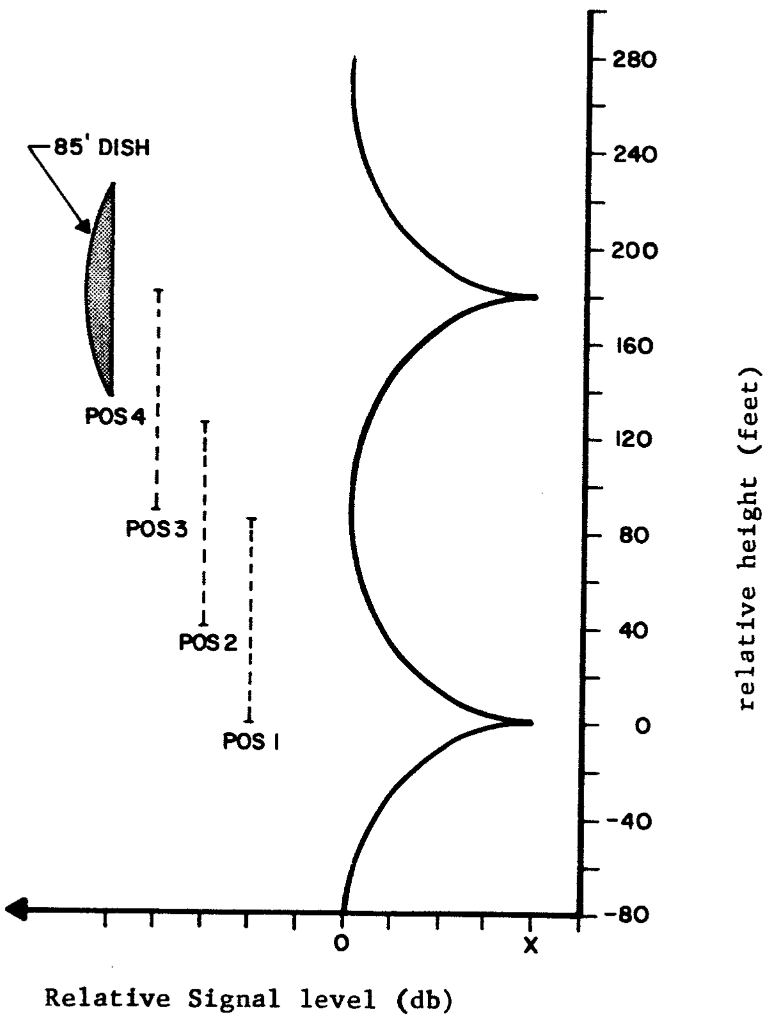
$$h_1 - h_2' = \frac{\delta\ d}{2h_1}$$

The distance between nulls is determined by letting δ equal 360° or one wavelength. For this condition (λ at 136 mc = 7.23 feet)

$$h_2 - h_2' = \frac{(7.23)\ (2500)}{2\ (50)}$$

$$= 180 \text{ feet between nulls}$$

By chance, the null pattern can be located almost anywhere with respect to the 85-foot dish, as illustrated in figure 2-4. It is seen from this figure that variations of field strength across the surface of the dish can be as great as 15 db for vertical polarization or 38 db for horizontal polarization. This would occur in position 1 or position 3. For position 4, a null is present at the center of the dish and a phase change of 180° occurs across this null. For the actual case in the field, these amplitude variations may not be nearly so severe, since the assumption of specular reflection only approximates actual site conditions. However, their effects cannot be neglected. The effect of these reflections on system performance will now be considered. For simplicity,



x = 15 db for vertical polarization.

x = 38 db for horizontal polarization

Figure 2-4. Possible Relationships Between the 85' Dish and the Interference Pattern assume antenna patterns of the form cos $K\Theta$. If the value of K is properly chosen, this assumption provides a fairly good approximation to the area between the first nulls of the pseudo-Bessel function produced from this type aperture. For the purposes of this analysis, assume direct energy E_d and reflected energy E_r, arriving at an angle δ and δ' respectively in relation to boresight. See figure 2-5.

The maximum amplitudes of the difference patterns is assumed to be unit and the beam offset is τ .

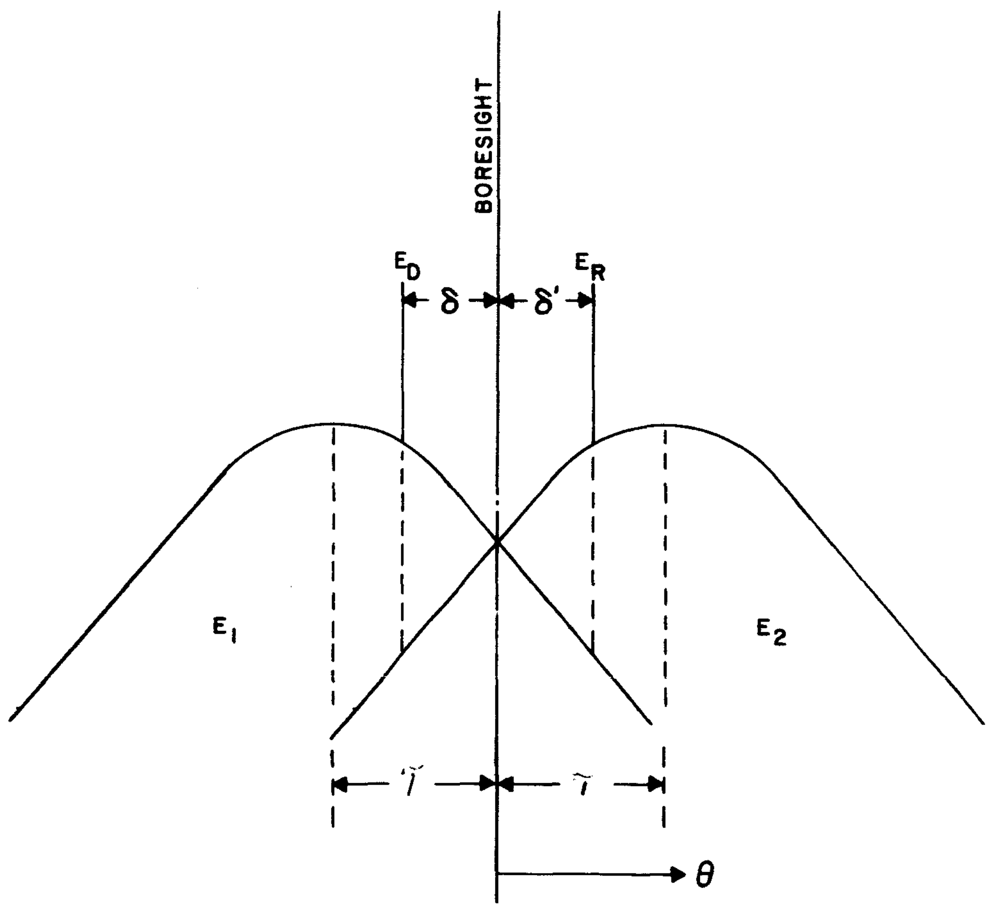


Figure 2-5. Squinted Beams of an Amplitude Monopulse Antenna

The voltage received in the right hand channel is given by

$$E_2 = E_d \cos K (\tau + \delta) + E_r \cos K (\tau - \delta')$$

The voltage received in the left hand channel is delayed by 180° in the comparator. It is given by

$$E_1 = E_d \cos K (\tau - \delta) - E_r \cos K (\tau + \delta')$$

These equations may be expanded as follows:

$$E_2 = E_d (\cos K\tau \cos K\delta - \sin K\tau \sin K\delta)$$

$$+ E_r (\cos K\tau \cos K\delta' + \sin K\tau \sin K\delta')$$

$$E_1 = -E_d (\cos K\tau \cos K\delta + \sin K\tau \sin K\delta)$$

$$- E_r (\cos K\tau \cos K\delta' - \sin K\tau \sin K\delta')$$

Now the error channel output is given by

$$E_1 + E_2 = -2 E_d \sin K\tau \sin \delta + 2E_r \sin K\tau \sin K\delta'$$

The direct energy is related to the reflected energy by the complex reflection coefficient. In addition, the reflected energy can have any phase relation to the direct energy, due to its different path length.

Thus, $E_r = R E_d \angle \phi$

where R = the magnitude of the reflection coefficient and ϕ = its relative phase. The error channel output now becomes:

$$E_1 + E_2 = 2 E_d \sin K\tau \ [(R \sin K\delta' (\cos\phi + j \sin \phi) - \sin K]$$

If $\phi = 0$, a null in the error channel can exist in several ways:

(1) $\delta = \delta' = 0$ (which is the case for no reflected energy and the antenna target on boresight):

(2) $R = 1$ and $\delta' = \delta$;

(3) or more generally $R \sin K\delta' = \sin K\delta$.

Temporarily assume that ϕ = zero. Now the boresight shift can be calculated as follows:

Assume $E_d = 1$, $K = 2\theta, r = 3°$, $\delta + \delta' =$ the grazing angle $= 2.3°$.

From figure 2-3, R = 0.975

Now $E_1 + E_2 = 2 \sin 60° \; (.975 \sin K\delta' - \sin K\delta)$

By a trial and error process, δ and δ' can be calculated to be 1.135° and 1.165° respectively for a perfect null. Thus, the boresight shift is 1.135°.

Generally ϕ is not zero, but some angle between 0 and ±180°. For this general case, it will be shown that a perfect null can not be obtained. The simplified error output is now

$$E_1 + E_2 = A \; [R \sin K\delta' (\cos \phi + j \sin \phi) - \sin K\delta]$$

where A is a constant.

The smallest signal available now occurs when $R \sin K\delta' \cos \phi = \sin K\delta$.

The error output is then $E_1 + E_2 = j\, AR \sin K\delta' \sin \phi$, which in general is not zero. Thus a perfect null is not obtained with a random phase reflected energy component.

Problems with reflections were quite apparent recently at the Fairbanks II installation. Briefly, the problem was that a satisfactory "s curve" could not be set up for horizontal polarization. Sum and difference X-Y patterns were run for both horizontal and vertical polarizations. All patterns were normal except the horizontally polarized difference pattern in the X plane. Although this pattern showed only a 10-db null, this depth is normally sufficient for tracking purposes. The receiver was set up in the normal manner and "s curve" analogs were run with different polarization and antenna configurations. The "s curve" for horizontal polarization was still unsatisfactory and indications were that the trouble was due to ground reflections. The receiver was set up and "s curves" run with the sun as a source. For this set up, the "s curves" were completely normal in all planes using first the horizontal elements, then the vertical elements, and then both. After this test several successful satellite tracks were performed and a boresight shift with polarization test was performed without loss of track. Thus, ground reflections were blamed for the problem.

In conclusion, ground reflections can constitute a serious problem in predicting operational system performance on the basis of operation with a collimation tower. The above analysis has shown that at Fairbanks II the field variations across the aperture of the 85-foot dish could be as great as 15 db for vertical polarization and 38 db for horizontal polarization. In addition, it was shown that null filling of the difference pattern can occur due to ground reflections.

It should be noted that the analysis derived in the preceeding pages is based on a model which yields qualitative, rather than quantitative, results. Nevertheless, the analysis does serve to establish the order of magnitude of the reflection effects. Measurements taken at Gilmore further substantiate the analysis. Figure 2-6 shows the relative r-f boresight shift as a function of the polarization of the boresight transmitter on the collimation tower. Since the ground reflection coefficient is functionally related to polarization, figure 2-6 is a direct measurement of the magnitude of the reflection effects. Similar effects were noted at Rosman and are summarized in the final report for the Rosman installation now in preparation.

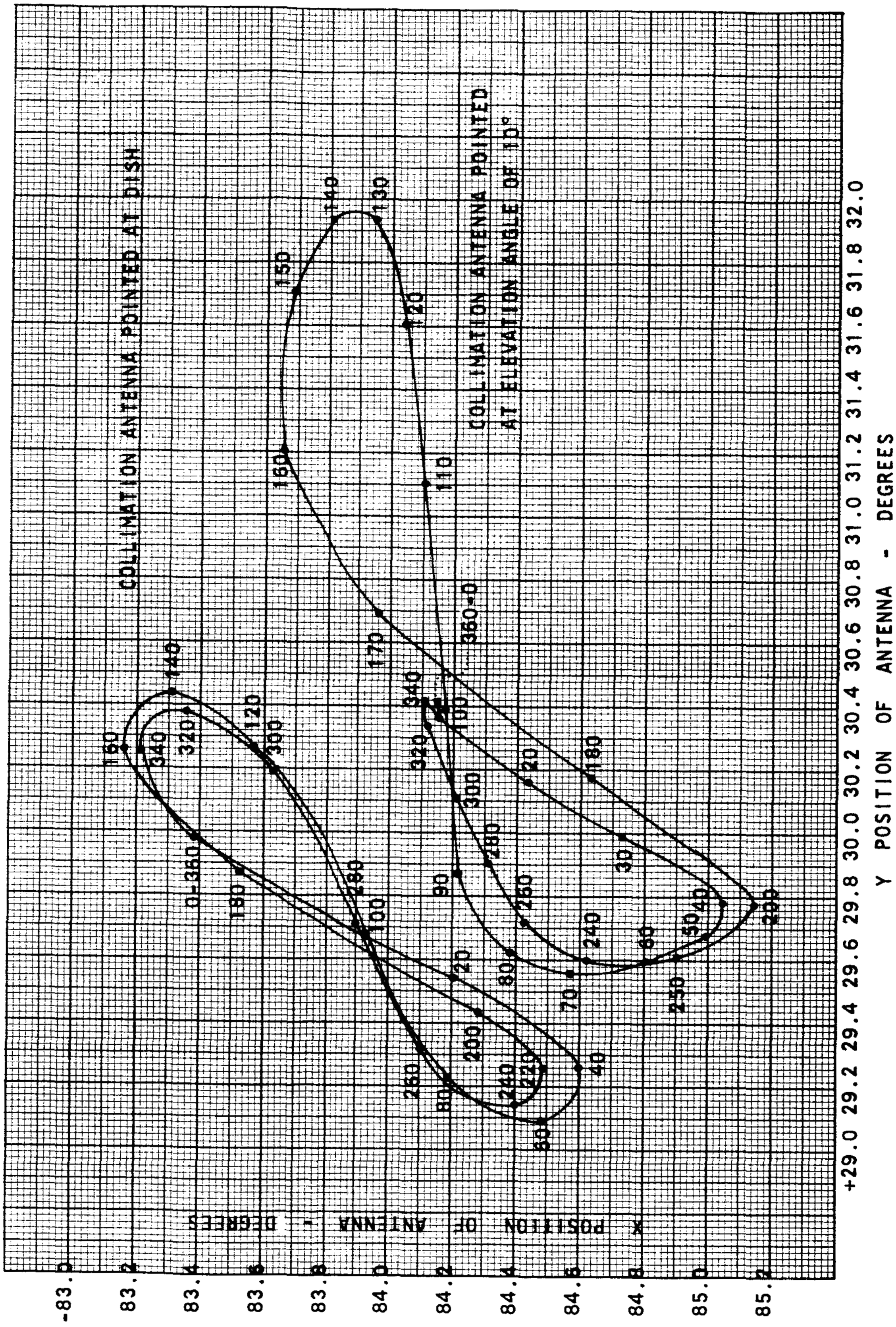


Figure 2-6. 136-Mc Boresight Shift with Polarization of Collimation Antenna

MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM TRACKING RECEIVERS

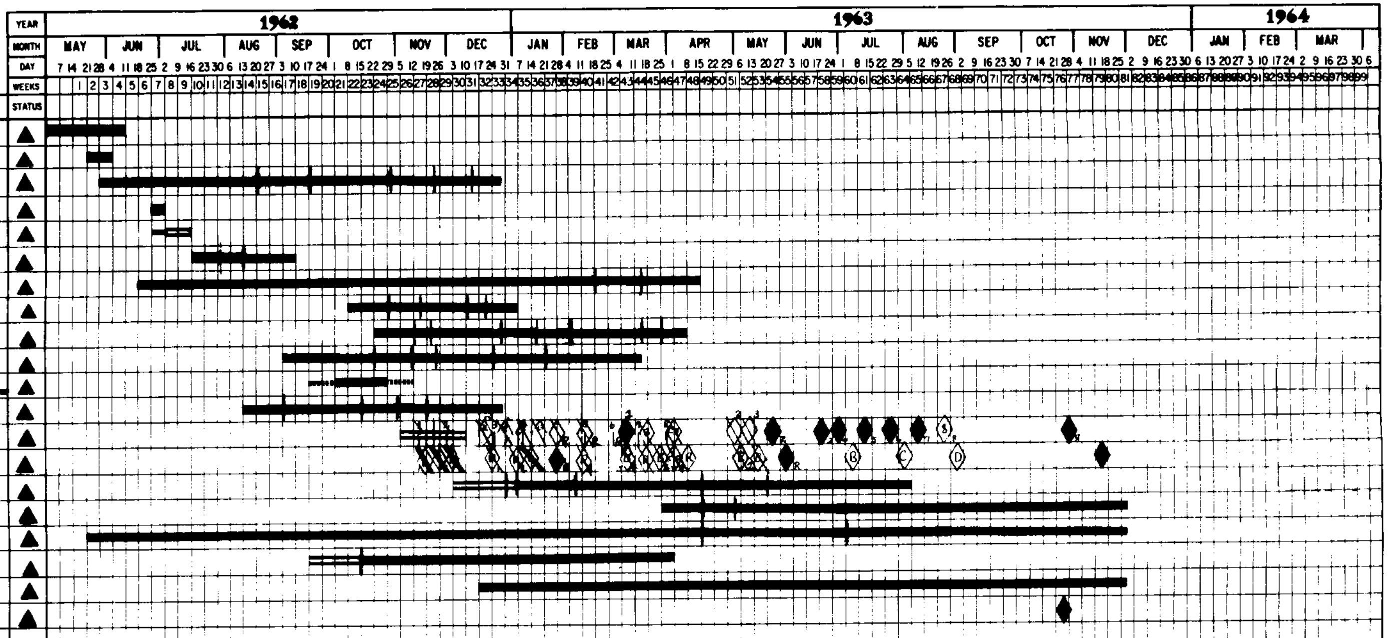
SUPPLIER COLLINS AND . . .

TRACKING RECEIVERS - ITT

Jim Makris
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1	FINAL SPECS	▲
2.	P. O. ACCEPTED	▲
3	DESIGN	▲
4.	DESIGN APPROVAL	▲
5.	COMPLETE BLOCK DIAGRAM	▲
6.	DELIVER CONSOLES TO SUB	▲
7.	FABRICATE	▲
8.	TEST PROCEDURE APPROVAL	▲
9.	PRELIMINARY INST. MANUAL	▲
10.	SPARE PARTS LIST	▲
~~11.~~	~~[illegible]~~	▲
12.	PROTOTYPE DESIGN EVALUATION	▲
13	ACCEPTANCE TESTS	▲
14	DELIVERY OF 8 UNITS	▲
15.	FINAL INSTRUCTION MANUALS	▲
16.	FINAL REPORT	▲
17.	MONITOR SUB EFFORT	▲
18.	ASSIST TRAINING OF INSTALL. PERS.	▲
19.	ENGINEERING BACK-UP FOR INSTALL.	▲
20.	SPARE PARTS PLACED ON ORDER	▲



section 3

tracking receivers

This section has been completed and only milestone monitoring will be continued.

section 3

tracking receivers

This section has been completed and only milestone monitoring will be continued.

MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM SIGNAL GENERATORS

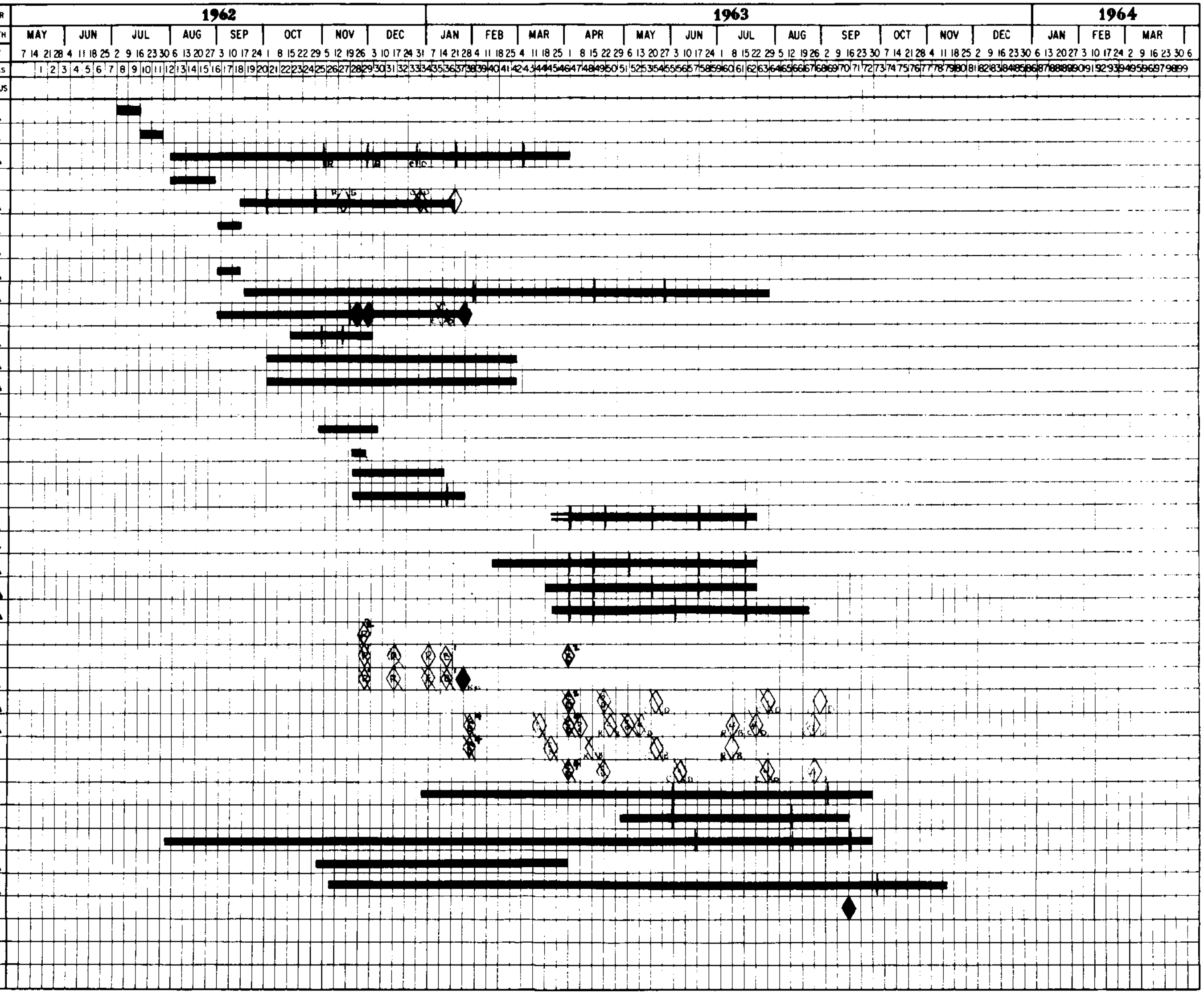
SUPPLIER COLLINS AND . . .

SIGNAL GENERATORS - DEI

Jim Roberts
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1	FINAL SPECIFICATIONS	▲
2	P. O. ACCEPTED	▲
3	DESIGN SIGNAL GENERATORS	▲
4.	DESIGN REMOTE CONTROL ATTENUATOR	▲
5.	DESIGN APPROVAL	▲
6.	INFO TO SUBCONTRACTOR FOR REMOTE	▲
	ATTENUATOR	▲
7.	COMPLETE BLOCK DIAGRAM	▲
8.	FABRICATE SIGNAL GENERATORS	▲
9.	FABRICATE REMOTE CONTROL ATTENUATOR	▲
10.	TEST PROCEDURE APPROVAL	▲
11.	PRELIMINARY INST. MANUALS	▲
12.	SPARE PARTS LIST	▲
13.	DELIVER REMOTE CONTROL ATTENUATOR	▲
	TO SUBCONTRACTOR	▲
14.	ACCEPTANCE TESTS, INTERIM CALIB.	▲
15.	ACCEPTANCE TEST, 136 MC COLL. SOURCE	▲
16.	ACCEPTANCE TEST, 400 MC COLL. SOURCE	▲
17.	ACCEPTANCE TEST, 1700 MC COLL.	▲
	SOURCE	▲
18.	ACCEPTANCE TEST, 136 MC CALIB.	▲
19.	ACCEPTANCE TEST, 400 MC CALIB.	▲
20.	ACCEPTANCE TEST, 1700 MC CALIB.	▲
21.	DELIVER INTERIM CALIB. 2 UNITS	▲
22.	DELIVER 136 MC COLL. SOURCE 4 UNITS	▲
23.	DELIVER 400 MC COLL. SOURCE 2 UNITS	▲
24.	DELIVER 1700MC COLL. SOURCE 2 UNITS	▲
25.	DELIVER 136 MC CALIB. 8 UNITS	▲
26.	DELIVER 400 MC CALIB. 4 UNITS	▲
27.	DELIVER 1700 MC CALIB. 4 UNITS	▲
28.	FINAL INSTRUCTION MANUALS	▲
29.	FINAL REPORT	▲
30.	MONITOR SUBCONTRACTOR EFFORT	▲
31.	ASSIST TRAINING OF INSTALL. PERS.	▲
32.	ENGINEERING BACK-UP FOR INSTALL.	▲
33.	SPARE PARTS PLACED ON ORDER	▲



section 4

signal generators

This section has been completed and only milestone monitoring will be continued.

MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM COMMAND TRANSMISSION SYSTEM

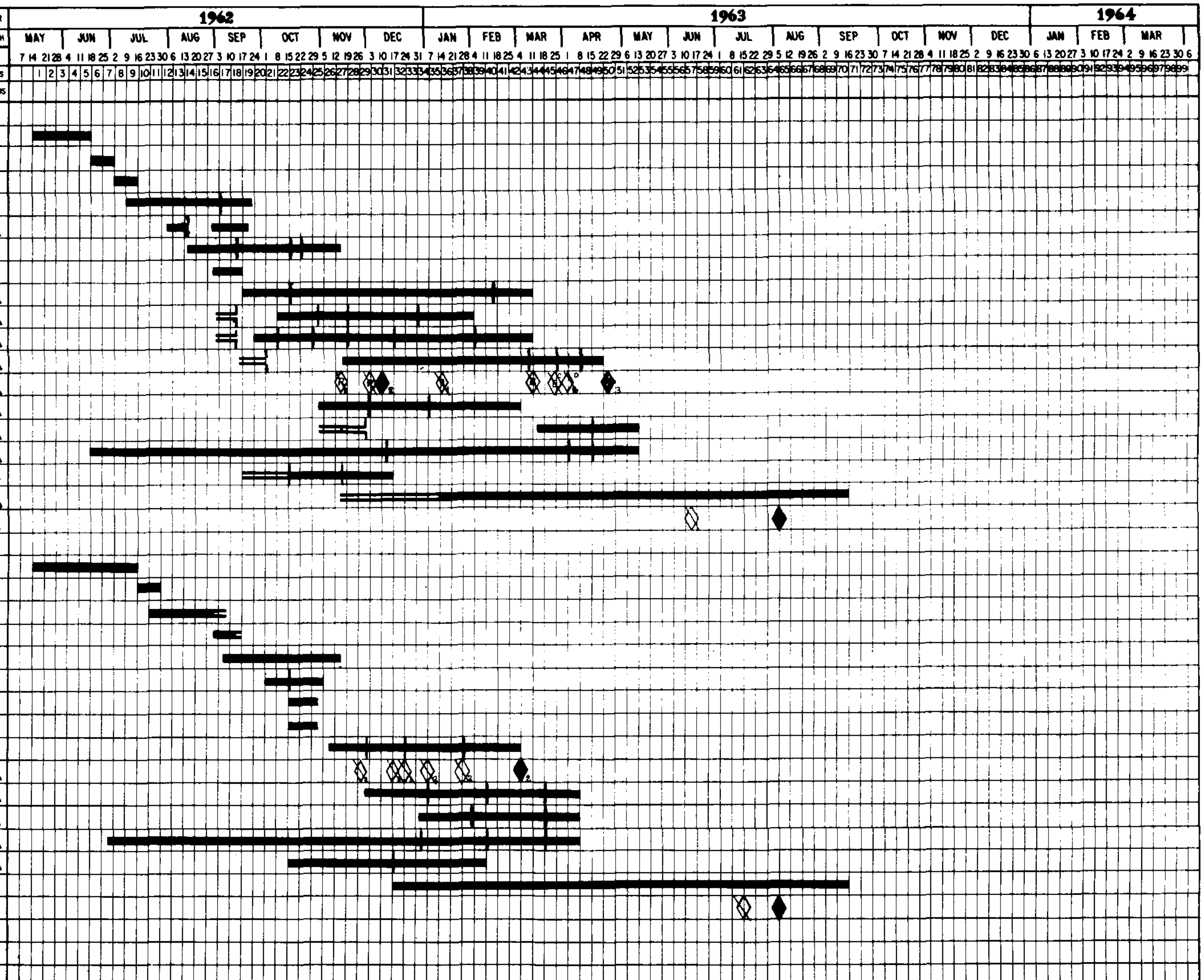
SUPPLIER COLLINS AND . . .

COMMAND ANTENNA - RADIATION SYSTEMS INC.
COMMAND XMTR -

........Jim Makris.......................................
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
	COMMAND ANTENNA	▲
1.	FINAL SPEC	▲
2.	FACILITY CHECK	▲
3.	P. O. ACCEPTED	▲
4.	DESIGN	▲
5.	APPROVE TEST PROCEDURES	▲
6.	PROTOTYPE TESTS	▲
7.	DESIGN APPROVAL	▲
8.	FABRICATE	▲
9.	PRELIMINARY INSTRUCTION MANUALS	▲
10.	SPARE PARTS LISTS	▲
11.	ACCEPTANCE TESTS	▲
12.	DELIVER 4 UNITS TO SITE	▲
13.	FINAL INSTRUCTION MANUAL	▲
14.	FINAL REPORT	▲
15.	MONITOR SUBCONTRACT EFFORT	▲
16.	ASSIST TRAINING OF INSTALL. PERS.	▲
17.	ENGINEERING BACK-UP FOR INSTALL.	▲
18.	SPARE PARTS PLACED ON ORDER	▲
	COMMAND TRANSMITTER	▲
19.	FINAL SPECIFICATION	▲
20.	P. O. ACCEPTED	▲
21.	DESIGN	▲
22.	DESIGN APPROVAL	▲
23.	FABRICATE	▲
24.	APPROVE TEST PROCEDURES	▲
25.	PRELIMINARY INSTRUCTION MANUALS	▲
26.	SPARE PARTS LIST	▲
27.	ACCEPTANCE TESTS	▲
28.	DELIVER 2 UNITS TO ROSMAN	▲
29.	FINAL INSTRUCTION MANUALS	▲
30.	FINAL REPORT	▲
31.	MONITOR SUBCONTRACT EFFORT	▲
32.	ASSIST TRAINING OF INSTALL. PERS.	▲
33.	ENGINEERING BACK-UP FOR INSTALL.	▲
34.	SPARE PARTS PLACED ON ORDER	▲



section 5

command transmission system

5.1 PROGRESS REPORT ON ROSMAN I COMMAND ANTENNA.

The command antenna at the Rosman I tracking station has experienced three mechanical failures since the initial installation. Each failure has occurred in or very near a welded section.

The first two failures occurred in the weld of the transition between the 4-1/2-inch and the 6-inch mast sections. The welded joint was not sufficient to carry the bending moment imposed on that section. Gusset plates were added in order to carry the bending moments across the weld area.

The third failure occurred in the heat affected weld zone of the mounting tube. The original mounting tube (6061-T-6 aluminum, 3/16-inch wall) was changed to a carbon steel tube with a 0.237-inch wall thickness. This material change increases the allowable bending moment by 4.56. The factor of safety for the mounting tube section is now 3.9 * for an inertial load of $12°/sec^2$.

A metallurgist's analysis on the third failure is included in figure 5-1. The analysis shows that the mast failed as a result of a fatigue fracture.

When a member is subjected to many cycles of repeated loading, it eventually may fail, even though the maximum stress in any cycle is considerably below the static strength of the material. The failure begins by the formation of minute cracks which grow larger with repeated loading until the strength of the material is lowered to the extent that a complete fracture occurs.

* Based on maximum allowable fatigue stress.

	COLLINS RADIO COMPANY **QUALI TYENGINEERING CHEMICAL LABORATORY**	
DATE	**LABORATORY SERVICE ANALYSES**	PROJECT REPORT
TIME ON PROJECT	ROSMAN I COMMAND ANTENNA FAILURE ANALYSIS	ANALYST
CHARGE NUMBER	ANALYSIS REQUESTED	ANALYSIS APPROVED
FOR	DEPARTMENT	

REFERENCE

An aluminum antenna base was submitted to determine the cause of failure.

MATERIAL SUBMITTED

The base mounting flange from the Rosman I Command Antenna system.

SPECIFICATION REQUIREMENT

ANALYTICAL PROCEDURE

Microscopic examination of the failure area and metallographic examination of the cross section.

ANALYSIS

The fracture surface of this part showed the very distinctive "penned" effect that is characteristic of a fatigue fracture. The failure followed the line of the heat affected zone very closely. Metallographic examination shows cracks following the grain boundaries of the parent material and no signs of plastic flow that would normally be found in a ductile or tensile failure.

SUMMARY & COMMENTS

The failure is a fatigue failure, possibly started by the notch effect of the weld and the stress concentration arising from the transition from the rigid section within the flange to the flexible section outside the flange.

D-1324 (2-63)

Figure 5-1. Rosman I Command Antenna Failure Analysis

Unfortunately, present knowledge of fatigue is not sufficiently advanced to permit precise design for a specified life, even in simple parts. One difficulty in predicting the fatigue life of a part is that of finding the exact combination of loads imposed on the part.

Table 5-1 is a tabulation of the approximate average completely reversed flexural stresses that 6061-0 and 6061-T6 aluminum will withstand for various numbers of cycles. This table was obtained from the Alcoa Structural Handbook.

The following calculations are based on an assumed maximum load on the command antenna mast as a result of a constant acceleration of $12°/sec^2$ about each axis simultaneously in addition to the component of the dead load of the mast in each direction. The maximum allowable bending moment was based on an assumed flexural stress of 8000 psi.

Figure 5-2 shows the approximate orientation of the command antenna with respect to the X and Y axes. Figure 5-3 is a sketch of the command antenna showing the physical dimensions and the sections under consideration in the following calculations.

The resultant force (F_R), at section A-A, on the command antenna as a result of a $12°/sec^2$ constant acceleration, is found by determining the acceleration force about each axis independently and the following relationship:

$$F_R = \sqrt{F_x^2 + F_y^2}$$

$$F_x = \frac{W}{g}\left(A_t\right) + W\ (\sin 45°)$$

$$F_y = \frac{W}{g}\left(A_t\right) + W\ (\sin 45°)$$

Also $A_t = \alpha\ r$

where: F_x and F_y = the force about the respective axis

W = Weight of the command antenna from the section under consideration to the end of the mast

g = the acceleration constant

A_t = tangential acceleration

α = angular acceleration of the axis

r = distance from the axis to the command antenna

TABLE 5-1. AVERAGE COMPLETELY REVERSED FLEXURAL STRESSES

MATERIAL	MINIMUM ULTIMATE STRENGTH	100,000 CYCLES	1,000,000 CYCLES	10,000,000 CYCLES	100,000,000 CYCLES	500,000,000 CYCLES
6061-0	16,000 psi	16,000 psi	13,500 psi	11,000 psi	9500 psi	9000 psi
6061-T6	38,000 psi	31,000 psi	23,000 psi	17,000 psi	14,500 psi	13,500 psi

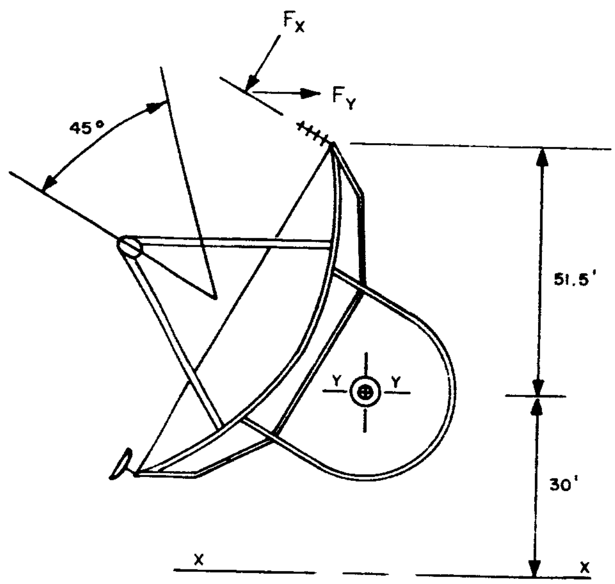


Figure 5-2. Command Antenna X-Y Orientation

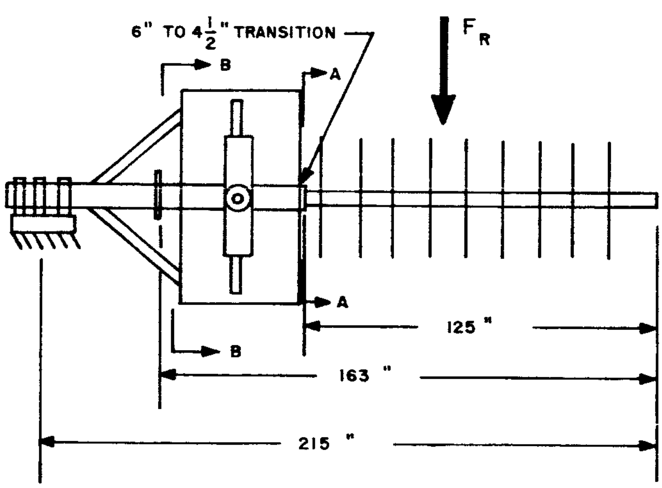


Figure 5-3. Command Antenna, Outline Drawing

$$F_x = \frac{50}{32.2}\left(\frac{12 \times 81.5}{57.2}\right) + 50\ (.707)$$

$$F_x = 61.7 \text{ lbs.}$$

$$F_y = \frac{50}{32.2}\left(\frac{12 \times 51.5}{57.2}\right) + 50\ (.707)$$

$$F_y = 52 \text{ lbs.}$$

The resultant force

$$F_R = \sqrt{(61.7)^2 + (52)^2}$$

$$F_R = 80.6 \text{ lbs.}$$

Assuming this force acts at the center of the mast section, the bending moment (M_{A-A}), at section A-A would be:

$$M_{A-A} = F_R \frac{(125)}{2}$$

$$M_{A-A} = 5050 \text{ in-lbs.}$$

The maximum allowable moment at section A-A, based on the flexural stress of 8000 psi is:

$$M_{max} = S\frac{I}{C}$$

Where:

M_{max} = maximum bending moment

S = allowable flexural stress = 8000 psi

$\frac{I}{C}$ = section modulus (4-1/2 dia. tube) = 2.64 in^3

$$M_{max} = 8000\ (2.64)$$

$$M_{max} = 21{,}120 \text{ in-lbs.}$$

The factor of safety (F.S.) $= \frac{M_{max}}{M_{A-A}}$

$$F.S. = \frac{21{,}120}{5{,}050} = 4.22$$

Similarly the bending moment at section B-B is found to be:

$$M_{B-B} = 18{,}500 \text{ in-lbs.}$$

The maximum allowable moment at section B-B (6" x 3/16" wall tube) is:

M_{max} = 38,000 in-lbs

F.S. = 2.06

5.2 CONCLUSIONS.

The above calculations show that the maximum allowable bending moments are not exceeded for the assumed loading. However, it is believed that a considerable amount of energy is imparted to the command antenna as a result of resonances from the primary structure. The imparted energy to the command antenna would of course increase the flexural stresses and greatly decrease the fatigue life. It is felt that the installation of Dacron guy lines will effectively dampen the oscillations of the command antenna and provide another path for the load to the base mounting structure.

MILESTONE SCHEDULE

GSFC FOUR STATION

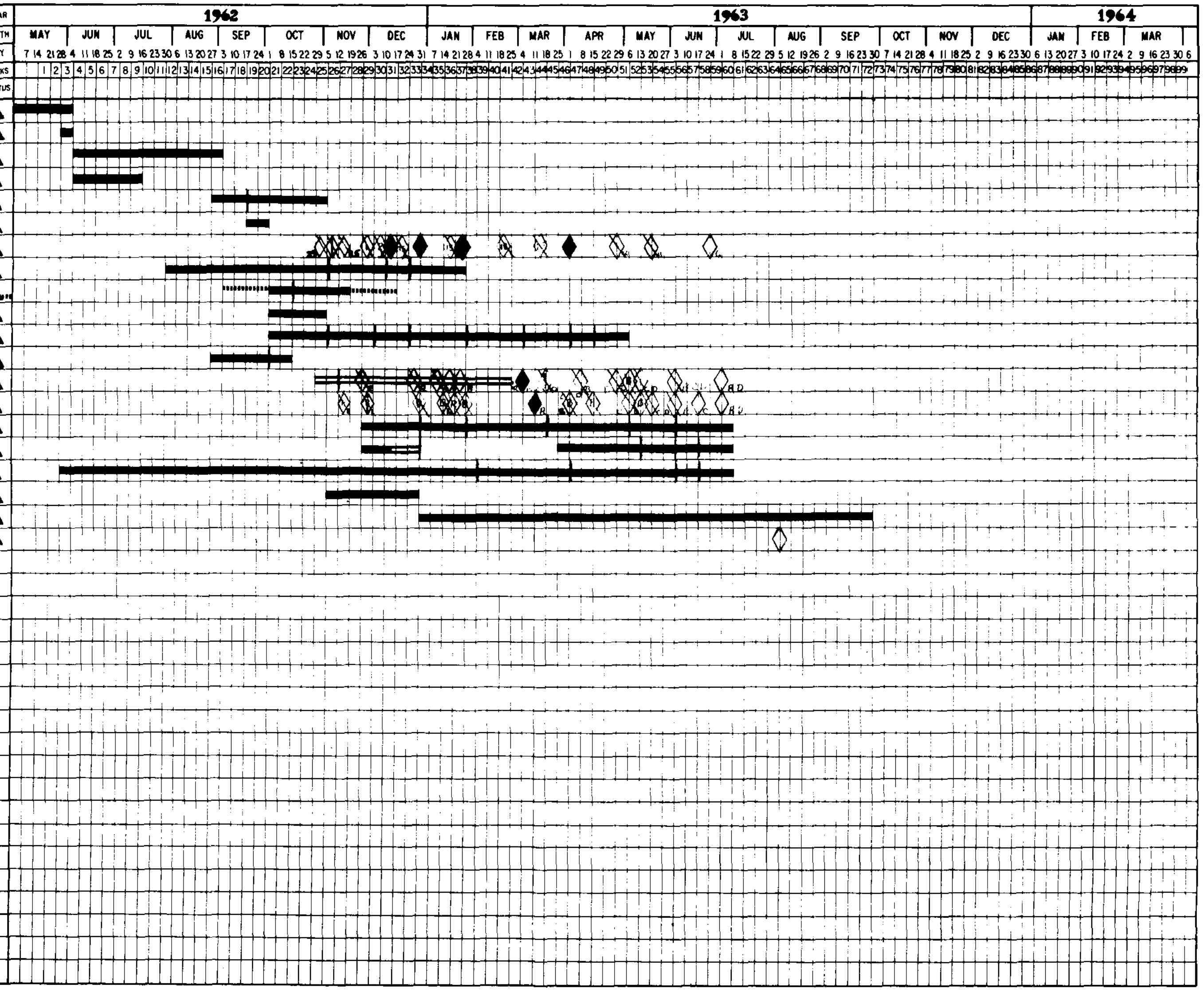
ITEM ANTENNA FEED

SUPPLIER COLLINS AND . . . RANTEC

Jim Makris
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1.	FINAL SPECS	▲
2.	P. O. ACCEPTED	▲
3.	DESIGN	▲
4.	HYBRID SELECTION	▲
5.	DESIGN APPROVAL	▲
6.	COMPLETE WIRING DIAGRAM	▲
7.	DELIVER COAX SWITCHES TO RANTEC	▲
8.	FABRICATION	▲
9.	[illegible]	△
10.	TEST PROCEDURES APPROVED	▲
11.	PRELIMINARY INSTRUCTION MANUALS	▲
12.	SPARE PARTS LIST	▲
13.	ACCEPTANCE TESTS	▲
14.	DELIVER 4 SYSTEMS TO SITE	▲
15.	FINAL INSTRUCTION MANUAL	▲
16.	FINAL REPORT	▲
17.	MONITOR SUB. EFFORT	▲
18.	ASSIST TRAINING OF INSTALL PERS.	▲
19.	ENGINEERING BACK-UP FOR INSTALL	▲
20.	SPARE PARTS PLACED ON ORDER	▲



section 6

antenna feeds

This section has been completed and only milestone monitoring will be continued.

MILESTONE SCHEDULE

GSFC FOUR STATION

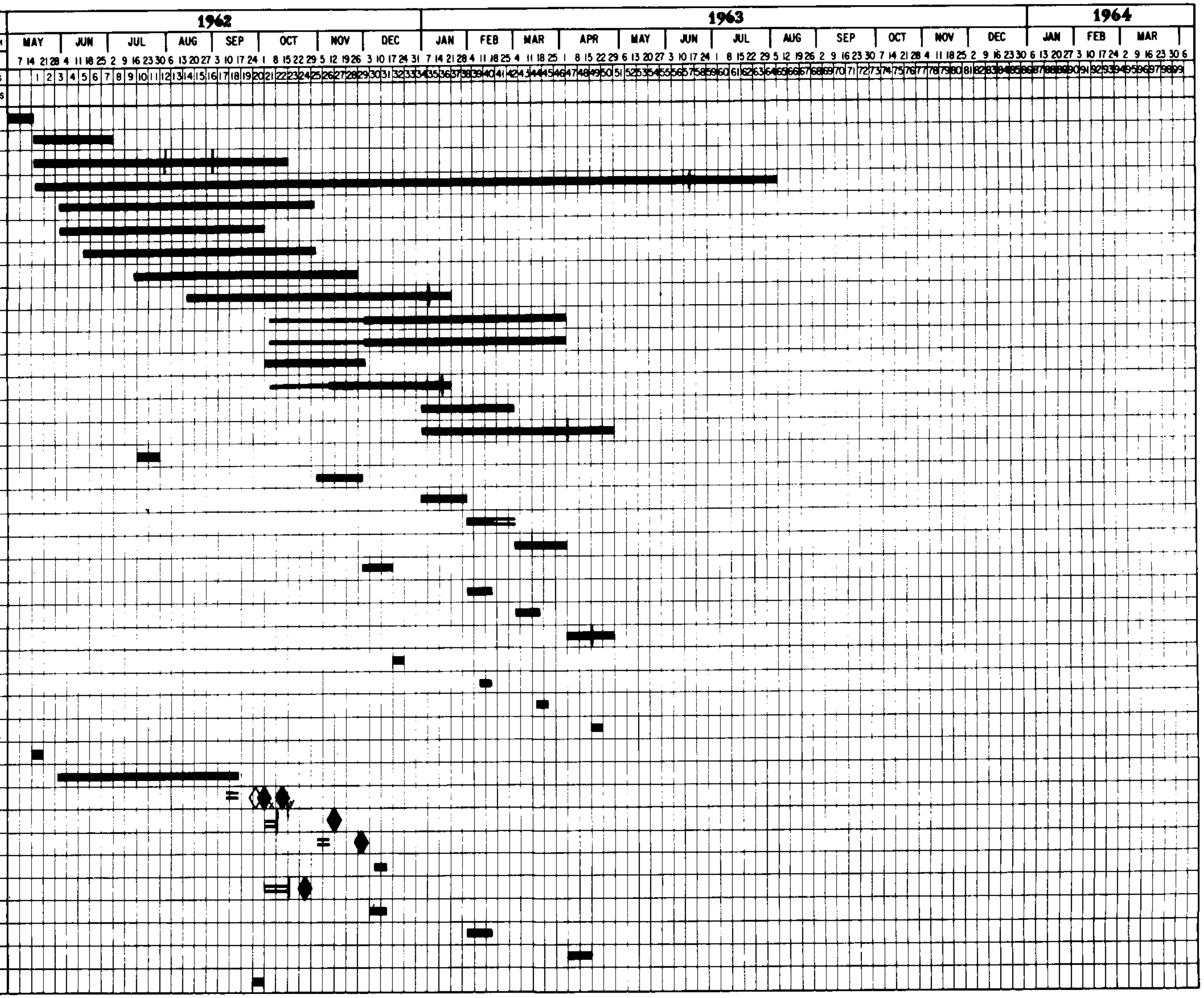
ITEM SERVO AND DRIVE SYSTEM

SUPPLIER COLLINS AND . . .
HYDRAULIC DRIVES - VICKERS

P. M. Green
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1	WRITE HYDRAULIC SPECS	▲
2	WRITE SERVO SYSTEM SPECIFICATION	▲
3	SYSTEM ANALOG COMPUTER STUDY	▲
4.	SYSTEM DESIGN AND REVIEW	▲
5	BASIC DESIGN OF UNITS	▲
6.	PURCHASED ITEMS	▲
7.	FABRICATION	▲
8	ASS'Y ROSMAN STATION UNITS	▲
9.	ASS'Y STATION B UNITS	▲
10	ASS'Y STATION C UNITS	▲
11.	ASS'Y STATION D UNITS	▲
12	UNIT TESTS ROSMAN STATION	▲
13.	UNIT TESTS STATION B	▲
14	UNIT TESTS STATION C	▲
15.	UNIT TESTS STATION D	▲
16.	SYSTEM CABLE INFORMATION	▲
17.	ASS'Y 1ST SYSTEM	▲
18.	ASS'Y 2ND SYSTEM	▲
19.	ASS'Y 3RD SYSTEM	▲
20.	ASS'Y 4TH SYSTEM	▲
21	TEST SUBSYSTEM #1	▲
22.	TEST SUBSYSTEM #2	▲
23	TEST SUBSYSTEM #3	▲
24.	TEST SUBSYSTEM #4	▲
25	PREPARE FOR SHIPPING #1	▲
26.	PREPARE FOR SHIPPING #2	▲
27	PREPARE FOR SHIPPING #3	▲
28.	PREPARE FOR SHIPPING #4	▲
29.	HYDRAULIC DRIVE P. O. ACCEPTED	▲
30	HYDRAULIC DESIGN AND REVIEW	▲
31	X & Y MOTORS TO ROHR - 1ST SYSTEM	▲
32.	X & Y MOTORS TO ROHR - 2ND SYSTEM	▲
33	X & Y MOTORS TO ROHR - 3RD SYSTEM	▲
34.	X & Y MOTORS TO ROHR - 4TH SYSTEM	▲
35	VICKERS FACTORY TEST - 1ST SYSTEM	▲
36.	VICKERS FACTORY TEST - 2ND SYSTEM	▲
37	VICKERS FACTORY TEST - 3RD SYSTEM	▲
38.	VICKERS FACTORY TEST - 4TH SYSTEM	▲
39.	DESIGN OF PIPING PUMP TO MOTORS	▲



MILESTONE SCHEDULE

GSFC FOUR STATION

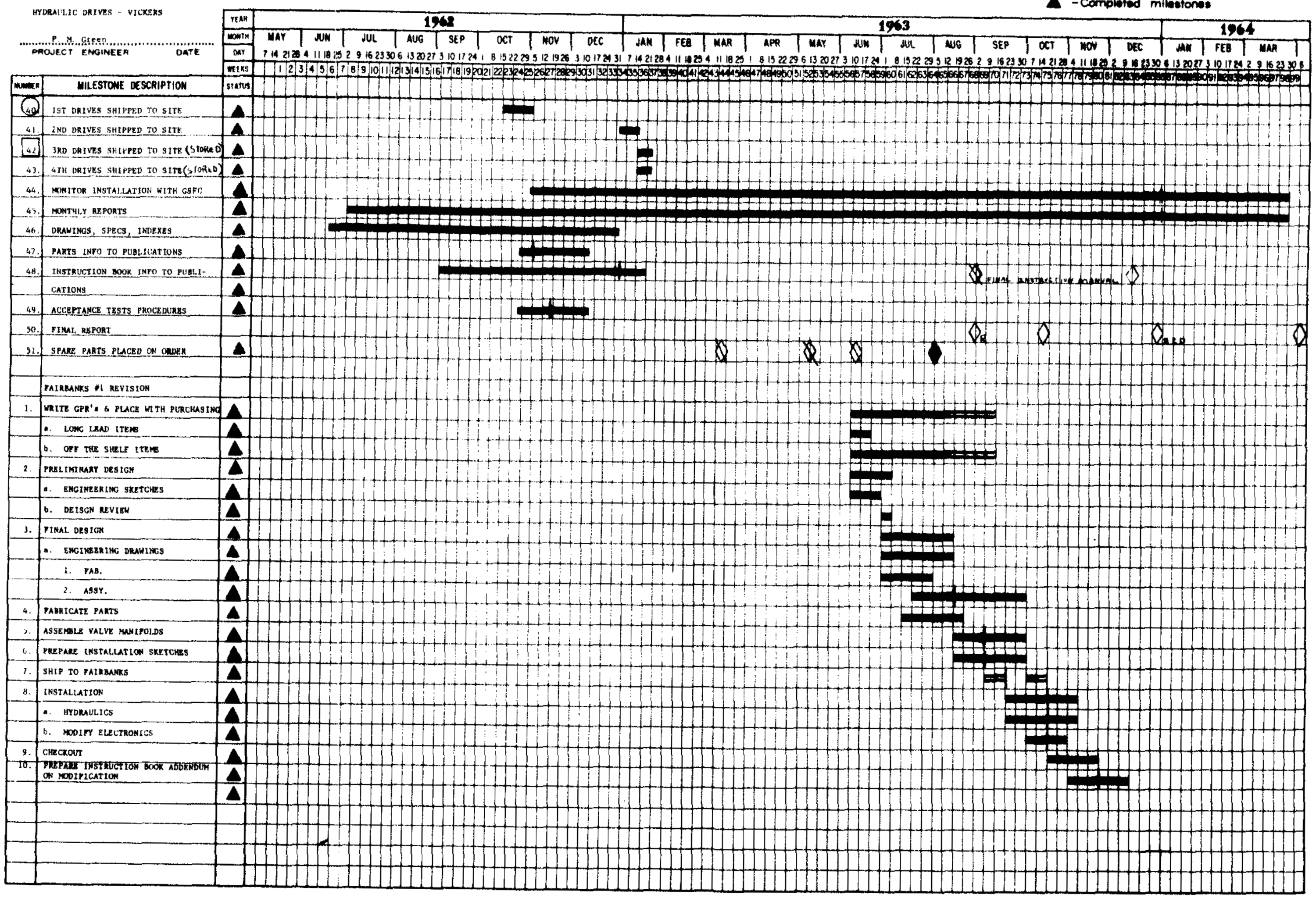
ITEM SERVO AND DRIVE SYSTEM

SUPPLIER COLLINS AND . . .

HYDRAULIC DRIVES - VICKERS

P. M. Green
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones



section 7

servocontrol system

7.1 GENERAL.

During the report period, the main emphasis was placed in the following work areas.

(1) Completion of the Fairbanks II station

(2) Monitoring hydraulic drives at Rosman and Fairbanks

(3) Conference at GSFC.

7.2 PROGRESS AND STATUS.

7.2.1 FAIRBANKS II STATION.

System testing on the Fairbanks II station was completed during the report period. Data on the complete system was collected during the month of March for analysis and evaluation. Several minor problems were encountered during this checkout but were resolved during the period. Data for the servosystem final report was also collected during the system testing. The final report for Rosman I and Fairbanks II will be completed in late May and submitted to GSFC.

All Collins personnel departed the Fairbanks station on 27 March 1964, with the exception of Mr. Earl Pillard. Mr. Pillard will remain on site to monitor the hydraulic system and to instruct the RCA operations and maintenance personnel.

7.2.2 MONITORING THE HYDRAULIC DRIVES AT ROSMAN I AND FAIRBANKS II.

Due to the failures that have been experienced in the hydraulic system at Rosman, several changes have been made on the existing system. A summary of the changes and troubles that occurred during the report period are described below.

The first indication of contamination on the modified X pump occurred during the previous report period and is described in the February report. Due to the misalignment of the yoke gear segments and the oscillations that occurred as a result of this condition, the contamination that was in the active system was thought to have been started at this time. Therefore, the pump was inspected for any damage that might have occurred with no additional modifications performed at this time.

The next failure occurred in the control pressure vane pump. A pressure relief valve had been placed across the vanes pump that was set to relieve if pressures exceeded approximately 1700 psi. When the unit was checked to determine the cause of the trouble it was found that the setting on the relief valve had been adjusted so high that the valve could not relieve. As a result, when the control pressure filter became partially clogged, the pressure drop across the pump would increase and cause excessive wear on the vane pump. This excessive wear also added to contamination of the system.

It then was decided that some means must be provided to insure that the pressure setting would not be adjusted after the correct setting had been made. The valve adjustment screw was drilled and safety wired to prevent adjustments after the initial setting. A lead seal also was attached to the adjustment screw. This seal would give a visual indication if the adjustment screw was moved.

After the vane pump was repaired and the system cleaned of contamination, operation returned to normal.

The contamination level began to increase again toward the end of the reporting period. When the unit was inspected by Collins and Vickers personnel it was found that the barrel assembly in the X pump was beginning to show grooves caused by excessive wear. A new barrel was ordered by Vickers and installed in the modified pump. The unit was reassembled and a 16-hour check run to check the contamination level. It was decided after a few hours operation that the replenishing filter area should be increased to prevent bypassing during cold start-up, and to prevent bypassing when the filters became partially clogged. An additional 24-gpm filter was placed in parallel with the existing replenishing filter as insurance against the bypassing condition.

The bypassing relief valve located in the filter case housing also was raised from approximately 45 to 70 psi by placing washers under the spring. New springs will be ordered to set the relief point at above 100 psi, if possible.

The Purolator Company, manufacturer of the filter cases is being contacted about this problem. A design goal maximum of 300 psi across the stainless steel mesh filter element is being set. Also it is recommended that differential pressure gages be installed across the replenishing filter cases for monitoring the pressure drop.

The modifications that have been placed on the Rosman station have also been added to the Fairbanks II station. Although no failures have been experienced on the modified pump at Fairbanks, very close monitoring of the hydraulics will continue in order to prevent failures such as those that have occurred at Rosman.

7.2.3 CONFERENCE AT GSFC.

A conference was held at GSFC during the report period to discuss and resolve the problems that have occurred at Rosman. Representatives from GSFC, Collins Radio Company and Vickers were present for this meeting.

Filtration of the hydraulic fluid was one of the main topics that was discussed. Due to the replenishing filter bypassing fluid during cold startup, contamination was allowed to enter the active system even after every precaution was taken to clean up the system after a failure. Mr. P. M. Green of Collins recommended that relief valve pressure in the filter cases be increased from approximately 45 psi to 300 psi. Action has already taken place on this problem as mentioned in the previous paragraph.

Mr. Green also recommended the following items:

(1) The stainless steel filter elements should be cleaned with ultrasonic cleaning or returned to Purolator for cleaning.

(2) Install an additional pressure gage to measure the control pump pressure which is the sum of the servo valve input pressure and the pressure drop across the filter.

(3) Maintenance techniques and procedures to be reviewed with Rosman operating personnel by GSFC and Collins Radio.

Action has been taken on all of the above mentioned recommendations.

7.3 PROGRESS FOR NEXT PERIOD.

Emphasis will be placed on the following work areas during the next reporting period.

(1) Updating and correcting unit schematics and servo instruction book.

(2) Analysis of Fairbanks I station.

MILESTONE SCHEDULE

GSFC FOUR STATION

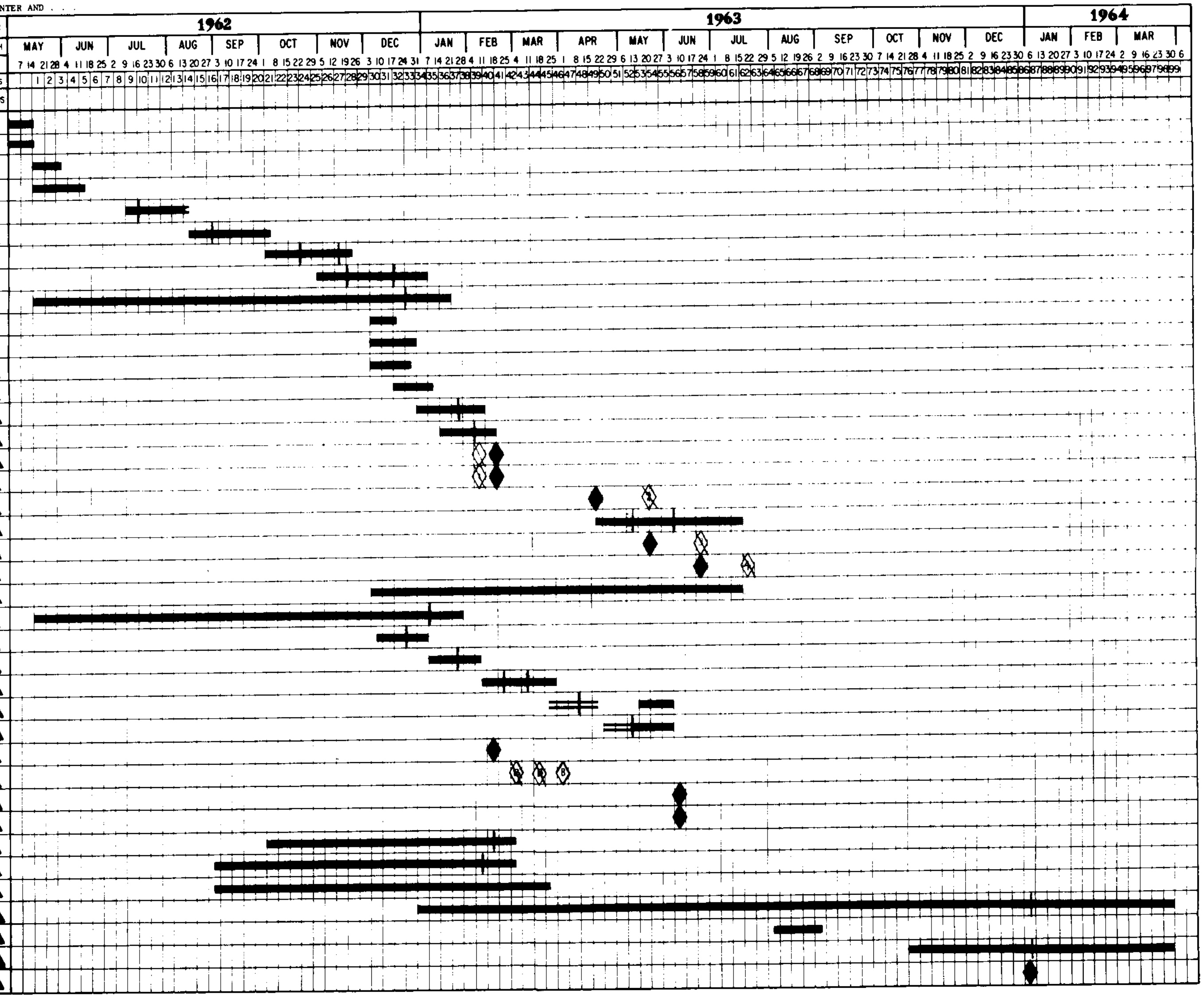
STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

ITEM: DATA SYSTEM
ANTENNA CONTROL STATUS SYSTEM

SUPPLIER: COLLINS DALLAS DIVISION
AND INFORMATION SCIENCE CENTER AND . . .

ENCODING SYSTEM - DATEX

B. Storey
PROJECT ENGINEER DATE



NUMBER	MILESTONE DESCRIPTION	STATUS
1.	TRL'S & SPECIFICATIONS COMPLETE	▲
2.	MAJOR SUBSYSTEM GPR'S COMPLETE	▲
3.	PURCHASE ORDERS RELEASED	▲
4.	ESTABLISH MONITORING CHECKPOINT BAR GRAPH	▲
5.	ENCODING SYSTEM DESIGN REVIEW	▲
6.	PROGRAMMER AND DATA CONVERTER LOGIC DESIGN REVIEW	▲
7.	10 MASTER VISUAL DISPLAYS TESTED AND ACCEPTED	▲
8.	10 MASTER VISUAL DISPLAYS TESTED AND ACCEPTED	▲
9.	60 REMOTE VISUAL DISPLAYS FROM MANUFACTURING	▲
10.	DATEX PRE-RELEASE ENCODING SYSTEM	▲
11.	DATEX COMPLETE RELEASE ENCODING SYS.	▲
12.	DRAFTING ENCODING SYSTEM	▲
13.	PROCUREMENT OF MATERIALS	▲
14.	PRODUCTION OF UNIT 1 ENCODER	▲
15.	CHECKOUT OF UNIT 1 ENCODER	▲
16.	ENCODING SYSTEM INST. MANUAL SPARE PARTS LIST REVIEWED & ACCEPTED	▲
17.	1ST ENCODING SYSTEM ACCEPTED	▲
18.	2ND ENCODING SYSTEM ACCEPTED	▲
19.	RETRO FIT UNIT NO. 1	▲
20.	3RD ENCODING SYSTEM ACCEPTED	▲
21.	4TH ENCODING SYSTEM ACCEPTED	▲
22.	ENCODING SYSTEM FINAL INSPECTION & DRAWINGS COMPLETED	▲
23.	FIRST PROGRAMMER AND DATA CONVERTER ASSEMBLY	▲
24.	DATA SYSTEM TEST PROCEDURE APPROVED	▲
25.	FIRST DATA SYSTEM ACCEPT. TEST	▲
26.	2ND SYSTEM ACCEPTANCE TEST	▲
27.	3RD SYSTEM ACCEPTANCE TEST	▲
28.	4TH SYSTEM ACCEPTANCE TEST	▲
29.	1ST DATA SYSTEM SHIPPED	▲
30.	2ND SYSTEM READY TO SHIP	▲
31.	3RD SYSTEM SHIPPED	▲
32.	4TH SYSTEM (READY TO SHIP)	▲
33.	INSTRUCTION MANUALS	▲
34.	SPARE PARTS LIST	▲
35.	DATA SYSTEM DRAWINGS	▲
36.	COORDINATION WITH FIELD PERSONNEL AND GSFC	▲
37.	SPECIFICATIONS UPDATED	▲
38.	FINAL REPORT	▲
39.	SPARE PARTS PLACED ON ORDER	▲

section 8

data systems and antenna control status system

All activity on the four data systems supplied under this contract has been completed with the exception of installation and testing. A detailed weekly report of installation and testing progress at the sites is provided in section 13 of this report.

MILESTONE SCHEDULE

GSFC FOUR STATION

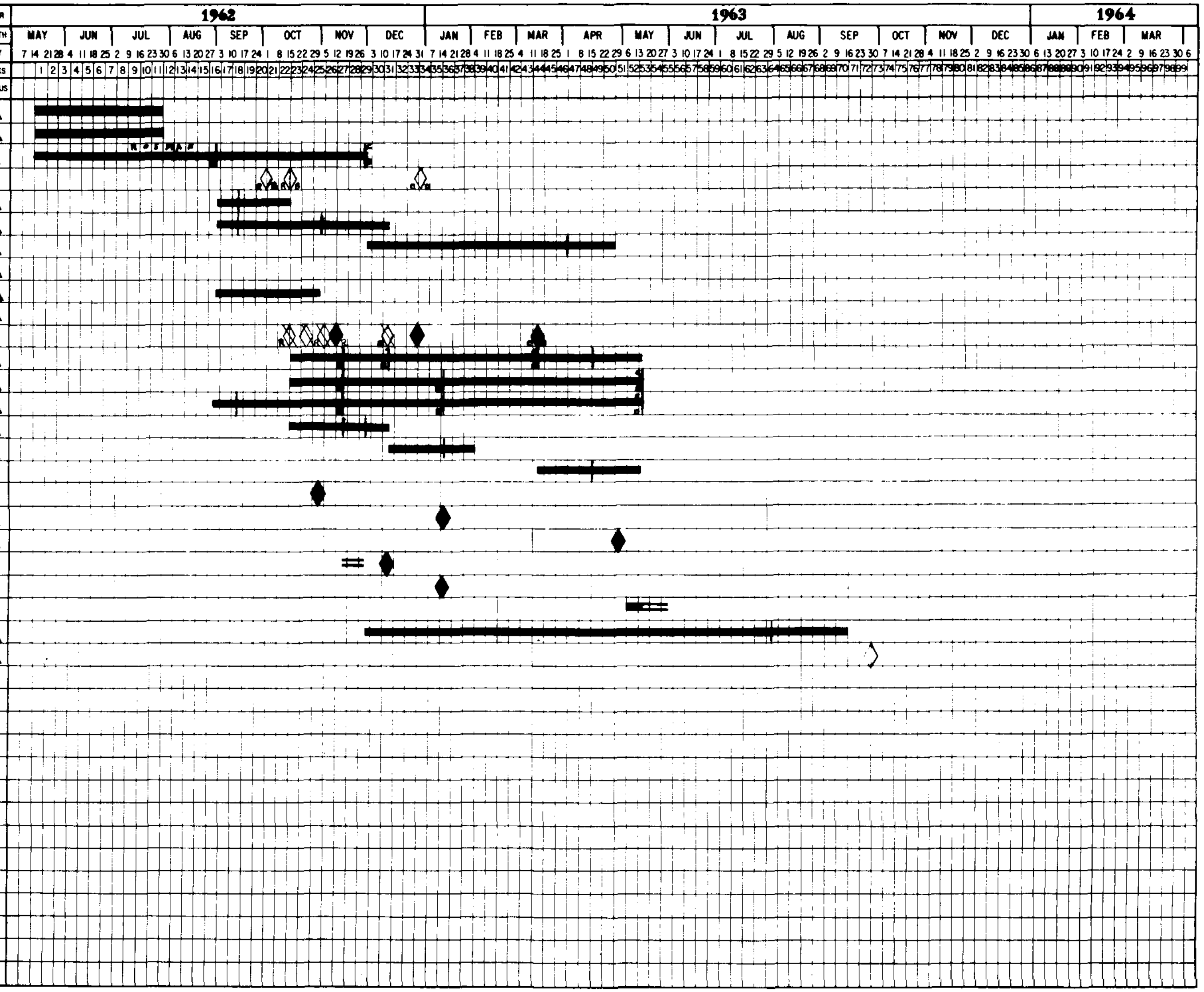
ITEM COLLIMATION SYSTEM

SUPPLIER COLLINS - DALLAS DIVISION

Jim Johnson
PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1.	SPECIFICATIONS COMPLETE	▲
2.	MAJOR PURCHASE ORDERS RELEASED	▲
3.	SYSTEM DESIGN	▲
4.	REMOTE CONTROL COMPONENT PARTS RECV	▲
5.	FAB OF REMOTE CONTROL SYS.-ROSMAN	▲
6.	FAB OF REMOTE CONTROL SYS. STA. B	▲
7.	FAB OF REMOTE CONTROL SYS. STA. C AND D	▲ ▲
8.	FAB OF COLLIMATION ANTENNAS - ALL STATIONS	▲ ▲
9.	ANTENNA ROTATORS RECEIVED	▲
10.	ACCEPTANCE TEST PROCEDURES	▲
11.	SPARE PARTS LIST	▲
12.	INSTRUCTION MANUALS	▲
13.	SYSTEM TESTS - ROSMAN	▲
14.	SYSTEM TESTS - STATION B	▲
15.	SYSTEM TESTS - STATION C & D	▲
16.	ROSMAN TOWER READY TO SHIP	▲
17.	STATION B TOWER READY TO SHIP	▲
18.	STATION D TOWER READY TO SHIP	▲
19.	ROSMAN EQUIPMENT SHIPPED TO SITE	▲
20.	STATION B EQUIPMENT READY TO SHIP	▲
21.	STATION C & D EQUIPMENT (STORED)	▲
22.	MONITOR INSTALLATION & GSFC TESTS	▲
23.	SPARE PARTS PLACED ON ORDER	▲



section 9

collimation system

This section has been completed and only milestone monitoring will be continued.

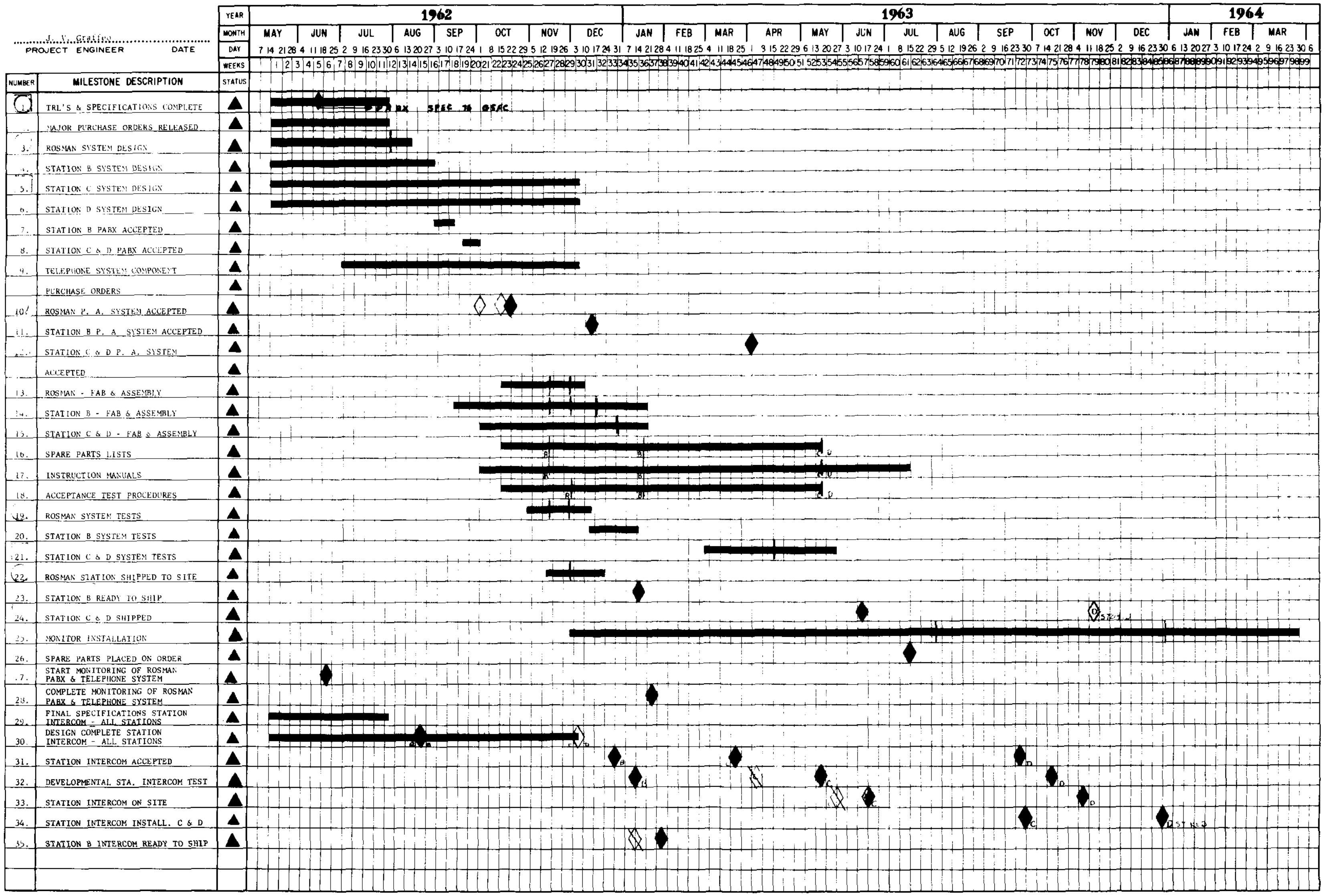
MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM COMMUNICATION FACILITIES

SUPPLIER COLLINS - DALLAS DIVISION

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones



section 10

communication facilities

This section has been completed and only milestone monitoring will be continued.

MILESTONE SCHEDULE

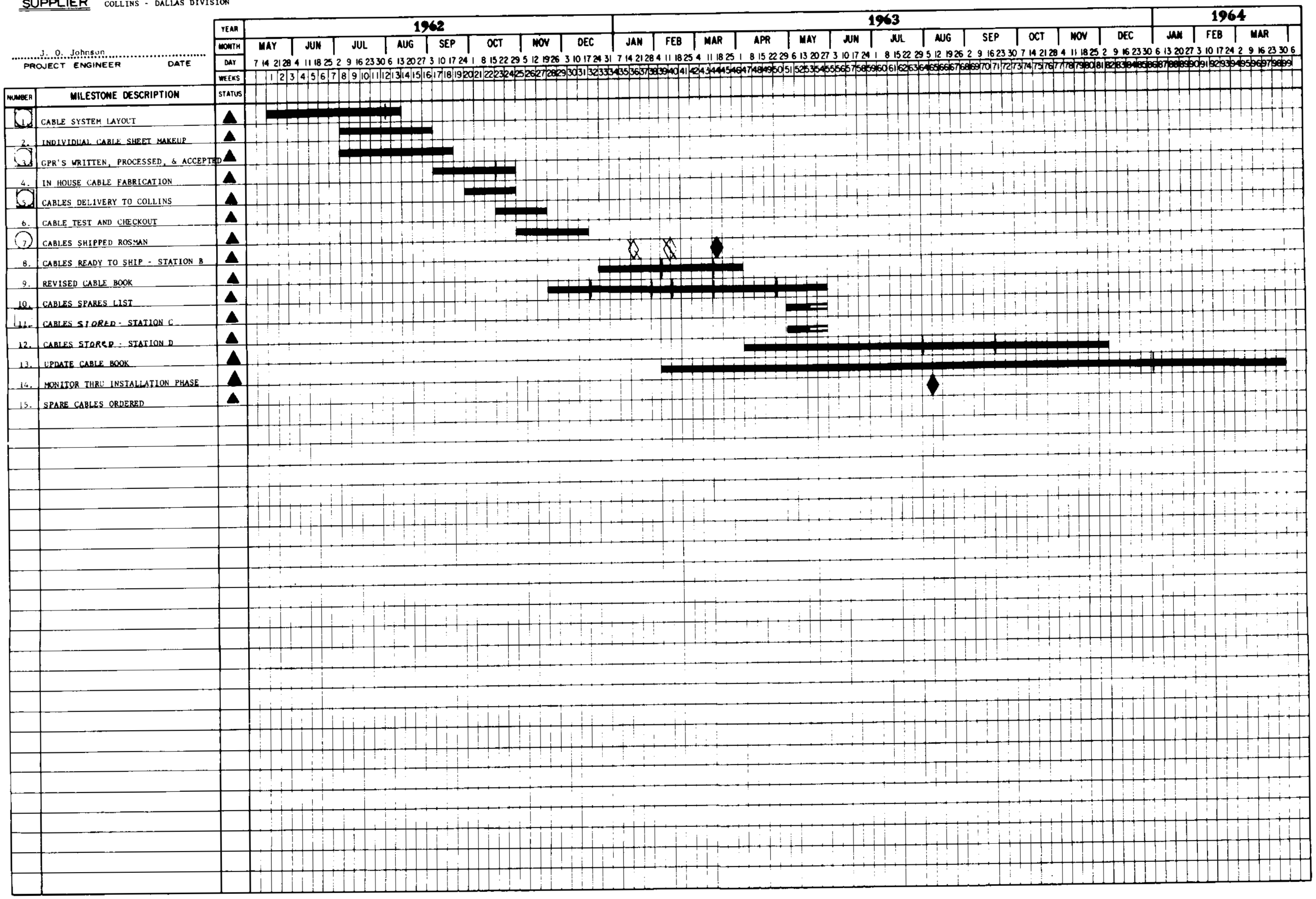
GSFC FOUR STATION

ITEM INTRASITE CABLING

SUPPLIER COLLINS - DALLAS DIVISION

J. O. Johnson
PROJECT ENGINEER DATE

STATUS-Shows milestone completion status
△ -Delayed and rescheduled milestones
▲ -Completed milestones



section 11

intrasite cabling

Cabling for the last two stations was received and placed in storage.

Gilmore Communication cabling documentation was completed.

MILESTONE SCHEDULE

ITEM STATION AND EQUIPMENT INTERFACE

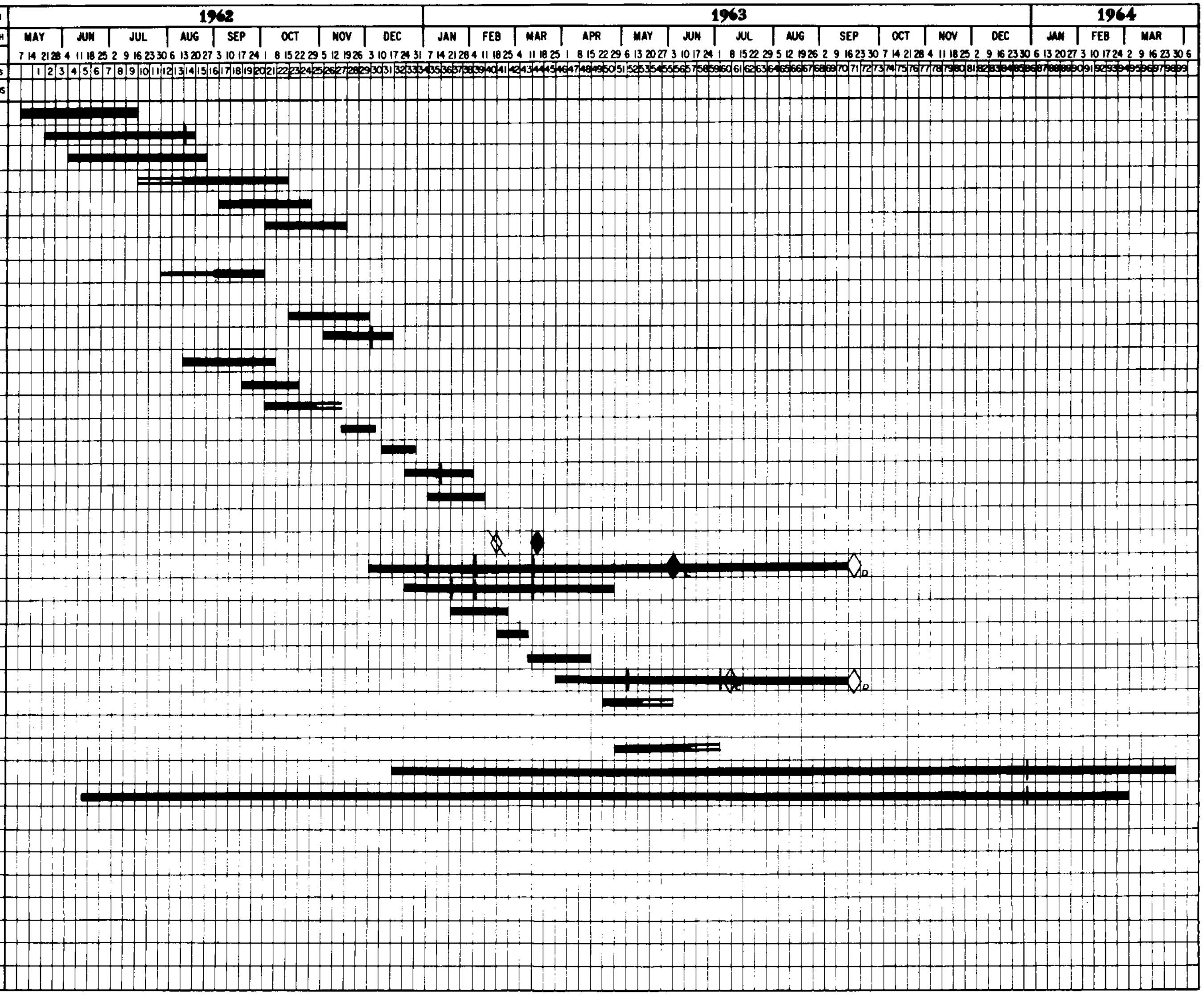
GSFC FOUR STATION

SUPPLIER COLLINS - DALLAS DIVISION

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

J. O. Johnson
PROJECT ENGINEER DATE

NUMBER	MILESTONE DESCRIPTION	STATUS
1.	ROSMAN STATION LAYOUT	▲
2.	ROSMAN RACK AND CONSOLE LAYOUT	▲
3.	ROSMAN RACK AND CONSOLE GPR'S	▲
4.	ROSMAN RACK AND CONSOLE DELIVERY	▲
5.	ROSMAN RACK AND CONSOLE PAINTING	▲
6.	ROSMAN RACK AND CONSOLE ASSY. & EQUIPMENT INSTALLATION	▲ ▲
7.	ANTENNA ELECTRICAL WIRING LAYOUT ALL FOUR STATIONS	▲ ▲
8.	ROSMAN TV MONITOR RACK FAB	▲
9.	ROSMAN EQUIPMENT SHIPMENT	▲
10.	STATION B LAYOUT	▲
11.	STATION B RACK & CONSOLE LAYOUT	▲
12.	STATION B RACK & CONSOLE GPR'S	▲
13.	STATION B RACK & CONSOLE DELIVERY	▲
14.	STATION B RACK & CONSOLE PAINTING	▲
15.	STATION B TV MONITOR RACK FAB	▲
16.	STATION B RACK & CONSOLE ASSY. AND EQUIPMENT INSTALLATION	▲ ▲
17.	STATION B EQUIPMENT READY TO SHIP	▲
18.	STATIONS C & D LAYOUT	▲
19.	STATIONS C & D RACK & CONSOLE LAYOUT	▲
20.	STATIONS C & D RACK & CONSOLE GPR'S	▲
21.	STATIONS C & D RACK & CONS. DELIVERY	▲
22.	STATIONS C & D RACK & CONSOLE PAINTING	▲
23.	STATIONS C & D RACK & CONSOLE ASSY & EQUIPMENT INSTALLATION	▲
24.	STATIONS C & D TV MONITOR RACK FAB	▲ ▲
25.	STATIONS C & D EQUIPMENT (STORED)	▲
26.	MONITOR OF EQUIPMENT INSTALLATION	▲
27.	MISC. INTERFACE EQUIPMENT GPR'S	▲



section 12

station interface

This section has been completed and only milestone monitoring will be continued.

MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM INSTALLATION & CHECKOUT ROSMAN

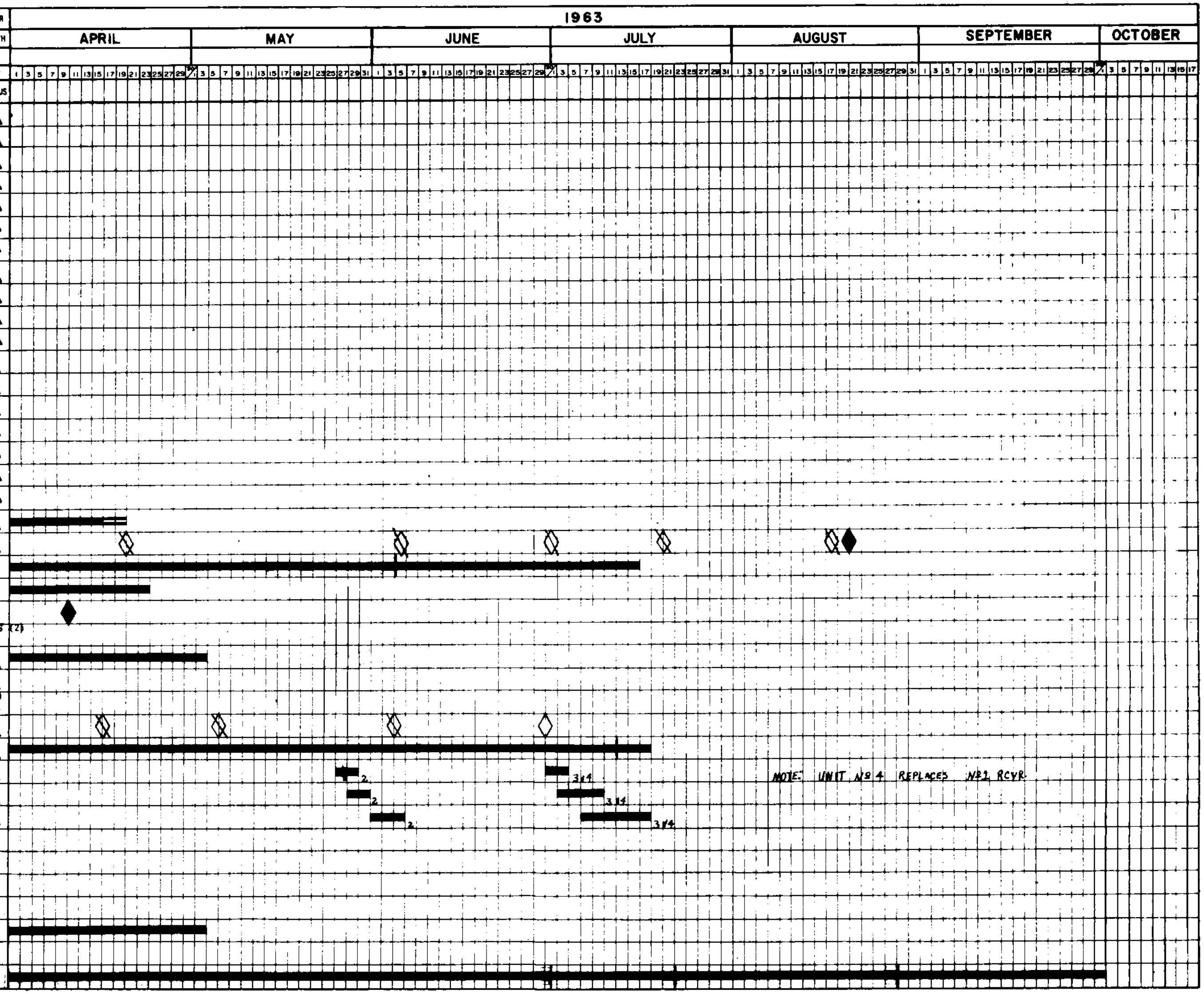
SUPPLIER

PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

YEAR: 1963 — MONTH: APRIL, MAY, JUNE, JULY, AUGUST, SEPTEMBER, OCTOBER

NUMBER	MILESTONE DESCRIPTION	STATUS
1	INSTALLATION CREW INDOCTRINATION	▲
	ROSE SUPERVISOR	▲
	GAMBLE SR. SERVO ENG.	▲
	FREDRICKSON SR. DATA ENG.	▲
	HONG SR. GENL. ENG.	▲
	BEAVER JR. GENL. ENG.	▲
	LOBBAN JR. GENL. ENG.	▲
	FULTON JR. SERVO/GENL. ENG.	▲
	PILLARD JR. SERVO/GENL. ENG.	▲
	DAY SR. RF ENG.	▲
	ATTEBERRY JR. RF ENG.	▲
	COLLINS SR. RF ENG.	▲
	MATTISON JR. DATA ENG.	▲
2	INSTALL X-AXIS HYDRAULIC PKG.	▲
3	INSTALL Y-AXIS HYDRAULIC PKG.	▲
4	TEMPORARY CREW ON SITE	▲
5	PERMANENT CREW ON SITE	▲
6	ELECTRICAL WIRING - ANTENNA & OPS ROOM	▲
7	CABLE INSTALLATION - POWER AND SIGNAL	▲
8	ANTENNA COMPLETION (GFE)	▲
9	RF EQUIPMENT	▲
	a. INSTALL EQUIP IN FEED BOX	▲
	(1) 136 MC PREAMP (2) 400 MC PARAMETRIC	▲
	(3) TEST SIGNAL DISTRIBUTION UNITS (2) (4) WIRE COAX SWITCHES	▲
	(5) AIR DUCTS	
	b. INSTALL OPS-ROOM EQUIPMENT	▲
	(1) SIGNAL SOURCE CONTROL PANEL (2) NOISE-FIGURE MEAS. SYS.	▲
	(3) TEST EQUIP. (SCOPE, VTVM, ETC.) (4) TEST EQUIP. SWITCH PANEL	▲
	(5) COLLIMATION XMTR. CONTROLS (6) CALIBRATORS - 136 & 400 MC	▲
	(7) POLARIZATION CONTROL PANEL	
10	TRACKING RECEIVERS (2)	▲
	a. INSTALL & APPLY POWER	▲
	b. CHECK & ALIGN	▲
	c. FINAL TESTS	▲
11	SPEC. PURPOSE T/M RECEIVERS	▲
	a. INSTALL	▲
	b. APPLY POWER	▲
	c. CHECKOUT & ALIGN	▲
	d. FINAL TESTING	▲
12	SHELTER @ BASE OF ANTENNA (GFE)	▲
13	COMMAND TRANSMISSION SYSTEM	▲



MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM

SUPPLIER

PROJECT ENGINEER .... DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

YEAR: 1963 / 1964
MONTH: JULY, AUGUST, SEPTEMBER, OCTOBER, NOVEMBER, DECEMBER, JANUARY

NUMBER	MILESTONE DESCRIPTION	STATUS
	a. INSTALL COMMAND ANT & CABLE	▲
	b. INSTALL COMMAND XMTR	▲
	c. SYSTEM CHECKOUT	▲
14	ANTENNA FEEDS	▲
	a. CHECKOUT POLARIZATION CONTROL	▲
	b. INSTALL & BORESIGHT	▲
	c. PATTERN MEASUREMENTS	▲
15	SERVO SYSTEM	▲
	a. INSTALL OPS ROOM EQUIPMENT	▲
	b. INSTALL ANT. EQUIPMENT	▲
	c. HYDRAULIC PIPING INSTL.	▲
	d. STATIC CHECKS-ELEC. & HYD.	▲
	e. OPERATIONS CHECKS	▲
	f. OPTIMIZATION	▲
16	DATA SYSTEM	▲
	a. INSTALL ENCODER	▲
	b. INSTALL OPS ROOM EQUIPMENT	▲
	c. ALIGN ENCODING SYSTEM & PERFORM SYSTEM CHECKOUT	▲
17	ANTENNA CONTROL STATUS SYSTEM	▲
	a. INSTALL CABLES & CABINETS IN PROJECT ROOMS	
	b. INSTL & CHECKOUT-OPS ROOM EQUIP	▲
18	COLLIMATION SYSTEM	▲
	a. ERECT TOWER	▲
	b. INSTALL & CHECK OPS ROOM EQUIP	▲
	c. INSTALL & CHECK TOWER MTD EQUIP	▲
	(1) ROTATOR & ANTENNA	
	(2) LIGHTS	▲
	(3) OPTICAL TARGETS	
	(4) CABLES	▲
	d. INSTALL & CHECK SHELTER EQUIP.	▲
	(1) COLLIMATION XMTRS.	▲
	(2) REMOTE ATTENUATOR	
	(3) DIPLEXER	▲
		▲
19	INSTALL & CHECK P/A SYSTEM	
20	INSTALL & CHECK OPTICAL PKG. (GFE)	▲
21	STAR TRACKS (OPTICAL & RADIO)	▲
22	STATION SYSTEM CHECKS-AIRCRAFT &	▲
	SATELLITE CHECKS	▲
23	STATION CHECKOUT COMPLETE	▲

MILESTONE SCHEDULE

GSFC FOUR STATION

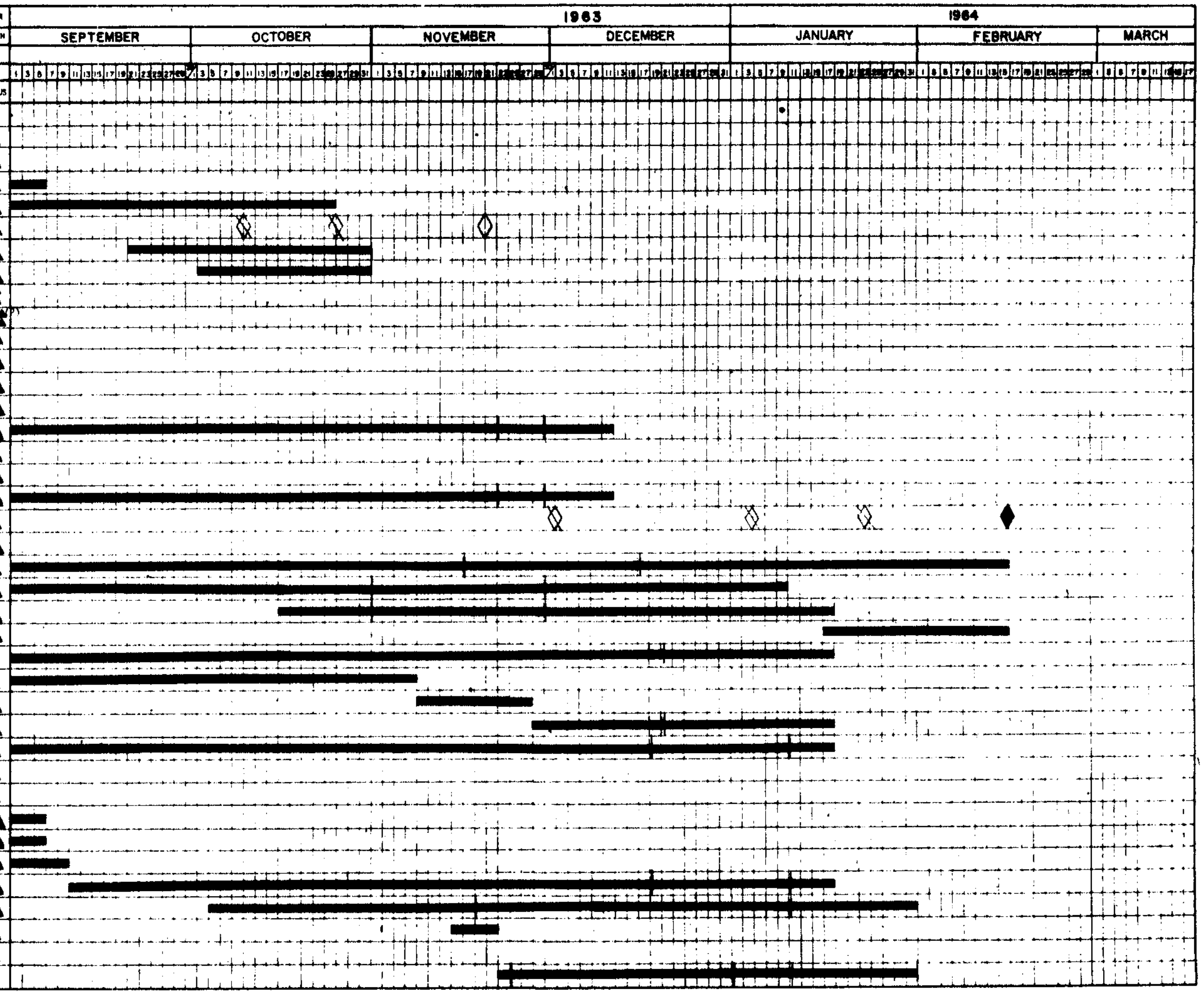
ITEM INSTALLATION & CHECKOUT FAIRBANKS NO. 2

SUPPLIER

PROJECT ENGINEER DATE

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

NUMBER	MILESTONE DESCRIPTION	STATUS
1.	INSTALL X-AXIS HYDRAULIC PKG.	▲
2.	INSTALL Y-AXIS HYDRAULIC PKG.	▲
3.	CREW ON SITE	▲
4.	ELECTRICAL WIRING - ANTENNA & OPS ROOM	▲
5.	CABLE INSTALLATION - POWER AND SIGNAL	▲
6.	ANTENNA COMPLETION (GFE)	△
7.	RF EQUIPMENT	▲
	a. INSTALL EQUIP IN FEED BOX	▲
	(1) 136 MC PREAMP	▲
	(2) 1700 MC PARAMETRIC	
	(3) TEST SIGNAL DISTRIBUTION UNITS (2)	▲
	(4) WIRE COAX SWITCHES	
	(5) AIR DUCTS	
	b. INSTALL OPS-ROOM EQUIPMENT	▲
	(1) SIGNAL SOURCE CONTROL PANEL	
	(2) NOISE-FIGURE MEAS. SYS.	▲
	(3) TEST EQUIP. (SCOPE, VTVM, ETC.)	▲
	(4) TEST EQUIP. SWITCH PANEL	
	(5) COLLIMATION XMTR. CONTROLS	
	(6) CALIBRATORS - 136 & 1700 MC	▲
	(7) POLARIZATION CONTROL PANEL	
8.	TRACKING RECEIVERS (2)	▲
	a. INSTALL & APPLY POWER	▲
	b. CHECK & ALIGN	▲
	c. FINAL TESTS	▲
9.	INSTALL GFE T/M RECEIVERS	▲
10.	SHELTER @ BASE OF ANTENNA (GFE)	▲
11.	COMMAND TRANSMISSION SYSTEM	▲
	a. INSTALL COMMAND ANT & CABLE	▲
	b. INSTALL COMMAND XMTR (GFE)	▲
	c. SYSTEM CHECKOUT	▲
12.	ANTENNA FEEDS	▲
	a. CHECKOUT POLARIZATION CONTROL	▲
	b. INSTALL & BORESIGHT	▲
	c. PATTERN MEASUREMENTS	△
13.	SERVO SYSTEM	▲
	a. INSTALL OPS ROOM EQUIPMENT	▲
	b. INSTALL ANT. EQUIPMENT	▲
	c. HYDRAULIC PIPING INSTL.	▲
	d. STATIC CHECKS-ELEC. & HYD.	▲
	e. OPERATIONAL CHECKS	▲
	f. OPTIMIZATION	▲
14.	DATA SYSTEM	▲
	a. INSTALL ENCODER	▲
	b. INSTALL OPS ROOM EQUIPMENT	▲
	c. ALIGN ENCODING SYSTEM & PERFORM SYSTEM CHECKOUT	▲



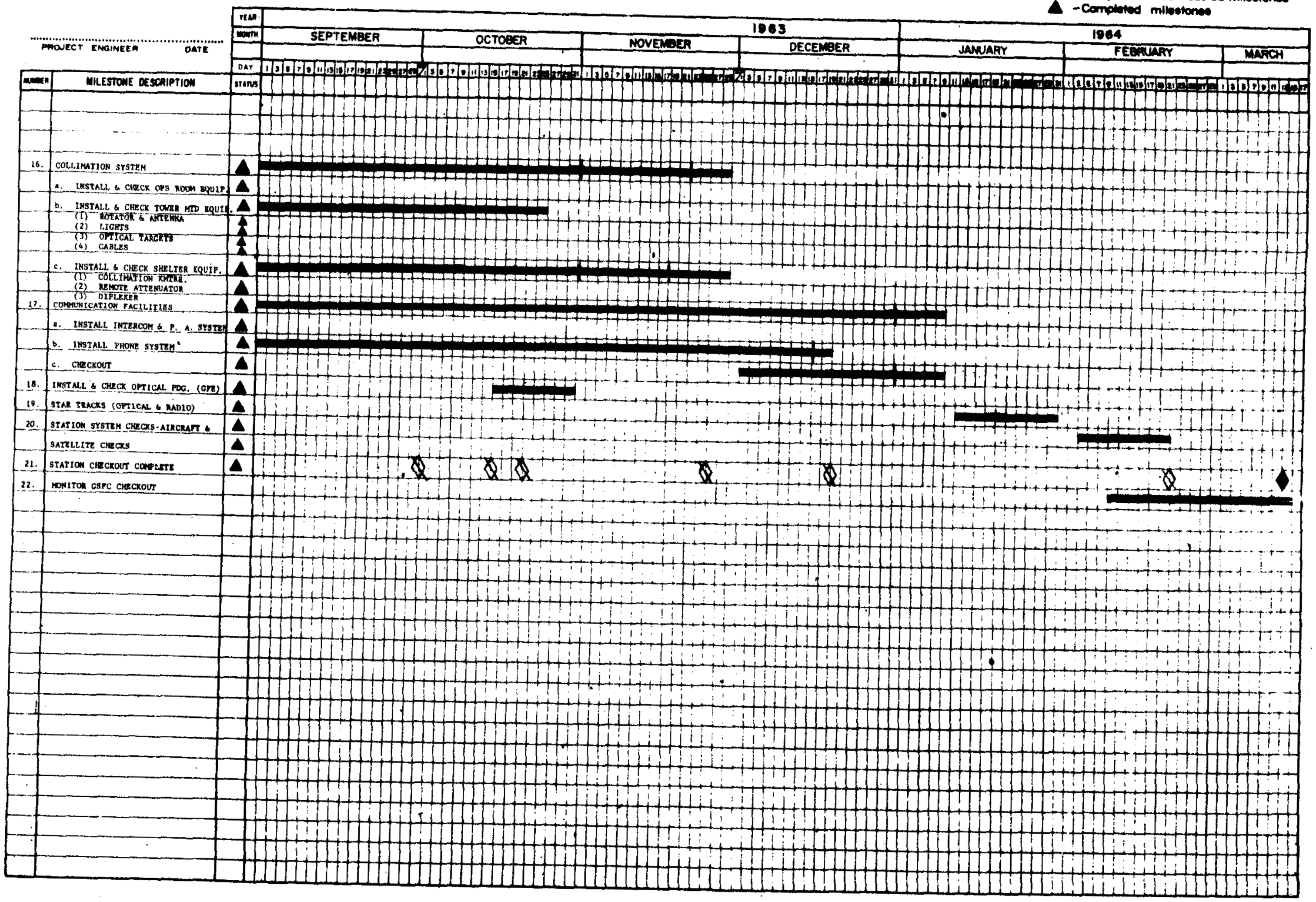
MILESTONE SCHEDULE

GSFC FOUR STATION

ITEM INSTALLATION & CHECKOUT FAIRBANKS NO. 2

SUPPLIER

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones



MILESTONE SCHEDULE

ITEM 1700 MC Addition at Rosman #1

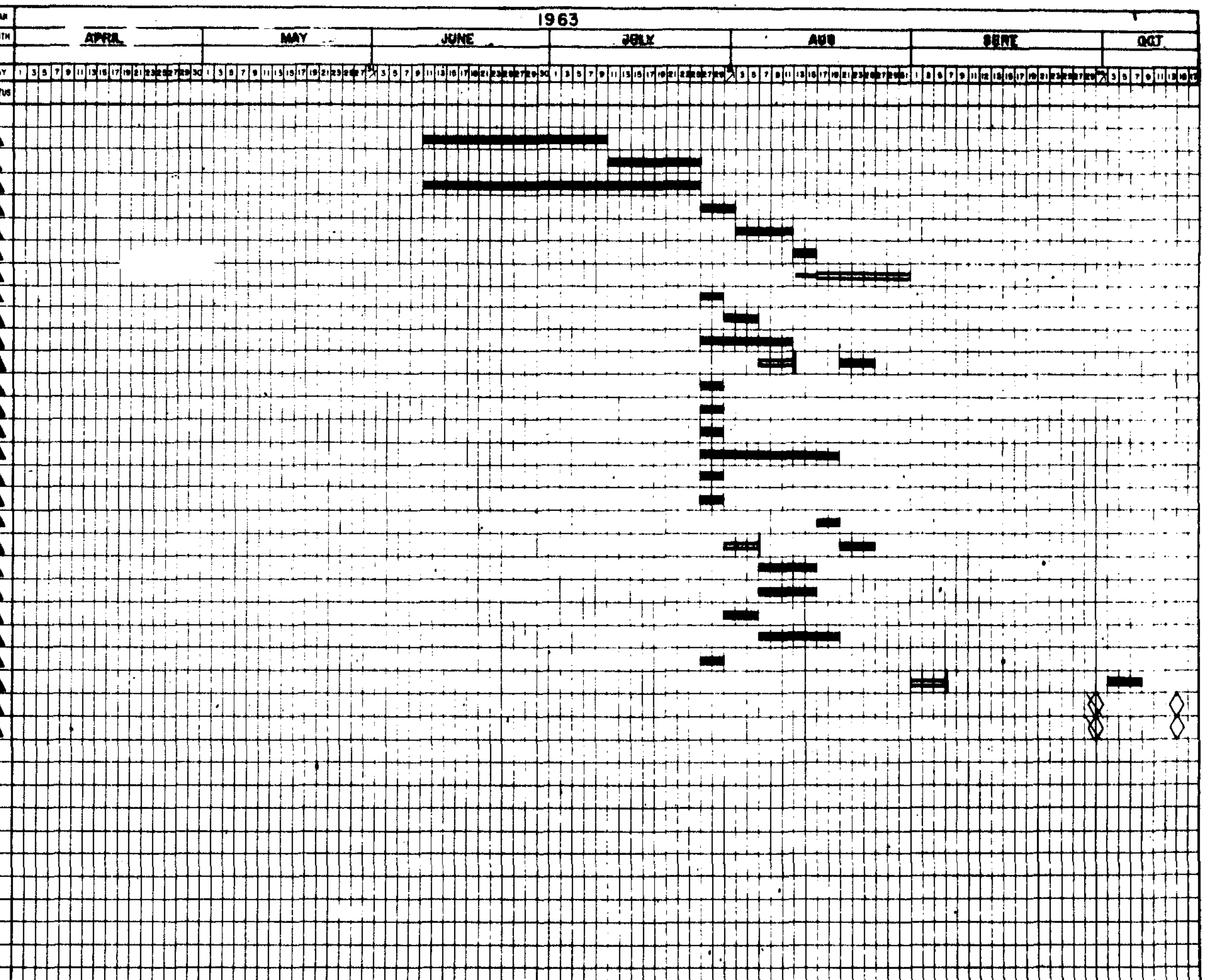
GSFC FOUR STATION

SUPPLIER

STATUS - Shows milestone completion status
△ - Delayed and rescheduled milestones
▲ - Completed milestones

PROJECT ENGINEER .... DATE

NUMBER	MILESTONE DESCRIPTION	STATUS
	INSTALLATION	
1	Design & Build LP Antenna	▲
2	Test & Calib. LP Antenna	▲
3	Design & Build Mods for Data System	▲
4	Install & Check out Tracking Receivers	▲
5	Align & Final Test Tracking Receivers	▲
6	Install & Check out 1700 MC Paramp/Converter	▲
7	Align & Final Test 1700 MC Paramp/Converter	▲
8	Install & Check out Telemetry Receivers & Multicouplers	▲
9	Align & Final Test Telemetry Receivers & Multicouplers	▲
10	Install Collimation System Equipment	▲
	a. LPA Antenna	▲
	b. 1700 MC Collimation Source	▲
	c. Remote Attenuator	▲
	d. Diplexer	▲
11	Install Equipment in Operations Room	▲
	a. 1700 MC Collimation Source Remote Control Panel	▲
	b. 1700 MC Calibrators	▲
	c. 1700 MC Paramp/Converter Remote Control Panel	▲
	d. Command Transmitter Remote Control Panels (GFE)	▲
	e. Cable to Noise Figure Measurement Equipment	▲
	f. Cable to Signal Source Control Panel	▲
	g. Test Equipment Rack	▲
12	Install Extra RF & Multiconductor Cabling	▲
13	Install & Check out Mods to Data System	▲
14	Perform 1700 MC System Tests	▲
15	Deliver addendums to Instruction Manuals	▲
16	Deliver Addendums to Spare Parts List	▲



section 13

installation and checkout

13.1 GENERAL.

13.1.1 ROSMAN.

Failure of the command antenna at the junction of backup structure and the ground plane resulted in fabrication and installation of a steel backup section to replace the aluminum section. In addition, turnbuckles were added to each lead of the guy system. The above improvements, plus repositioning of the polarization switch box as mentioned in the February report, appears to have resulted in a marked improvement in the stability of the command antenna. A complete analysis of the command antenna failure is contained in section 5 of this report.

The reworked TRW switches were installed in feed polarization switch circuits of both the 136- and 400-mc systems. Following this final installation, the r-f transmission system was made gas tight and the Collins installation was complete.

13.1.2 GILMORE.

The installation phase at Gilmore was completed on 26 March and the final members of the installation crew departed with the exception of one hydraulic-mechanical engineer who remained on site to complete certain hydraulic modifications and to install replacement switches in the antenna feed box.

13.2 INSTALLATION AND CHECKOUT AT GILMORE DATA ACQUISITION FACILITY.

13.2.1 PROGRESS SUMMARY 1 THROUGH 7 MARCH 1964.

13.2.1.1 GENERAL. This week's weather was somewhat cooler, with nighttime temperatures mostly well below zero (low -20°), and daytime above zero (high +18°).

Ted Hart and Joe Day worked Sunday, 1 March, to clear up some receiver problems, and system testing started clicking on Monday. By the end of the week Ted had completed his system tests, with the exception of two nights of star shots plus satellite and aircraft tracks.

On Friday, 6 March, we were informed that the calibration aircraft, which had been carrying an ETA of 10 March 1964 for some time, had been further delayed and would not leave the East Coast before Wednesday, 11 March.

The third General Dynamics telemetry receiver arrived on site the afternoon of Monday, 2 March.

During the week, RCA installed a 136.8-mc source on the far collimation tower. This facilitated carrying out the 24-hour static tracking stability test as Ted was able to switch from 136 to 1700 mc and vice-versa without having to move the antenna around.

The third (S/N 4) General Dynamics telemetry receiver was delivered to us on Monday, and most of the week was occupied with checkout and calibration. The number of faults encountered indicated that factory testing had not been as thorough as would normally be expected of a high quality receiver. Initially the unit would not receive at all. This trouble was traced to a coaxial plug inside the synthesizer drawer being connected to the wrong point.

A transistor was burned out while attempting to take measurements on the agc module. Since this had also happened during checkout/calibration of S/N 2, a modification was recommeneded to prevent future occurrences of this problem. With the manufacturer's and NASA's cognizance, Gilmore receivers will be modified on site. The replacement transistor which had been obtained for S/N 2 was used for S/N 4, and checkout activities continued.

Automatic gain control adjustment gave a lot of trouble, and it became evident that the inconsistent behavior of the agc circuit on receiver A was due to an intermittent fault. At the time of writing this problem has not been located, as it cleverly clears it itself before diagnostic measures can be completed.

The r-f module in receiver A was found to be badly misaligned, displacing the 3 MC response. This section was realigned.

The agc systems were set up while the receiver was in the "no fault" condition. When the intermittent fault reappears, and remains long enough, it will be diagnosed and cleared.

The other tests detailed in the report covering the week ending 15 February were successfully completed and the same general observations apply. The wiring in the afc module was changed to conform to the circuit diagram and to provide the two variable agc outputs, and a 100-ohm load was fitted in the output of the diversity combiner. R22 in the output module is labeled R27 on the cover of the module. The regular outputs from the 3.25-mc i-f module were found to be taken from J152 and J155 instead of from J153 and J156. These were left as found.

All the receivers become unstable when a signal of greater than -40 dbm is received and the bandwidth is 10, 30 or 100 kc with an agc speed of 3 ms. In operation these conditions are unlikely to obtain, but it is not completely impossible. Measures should therefore be taken to prevent this. The instability is evidently a function of the lag in the agc loop, as the effect is a blocking off of the i-f at an audio frequency.

13.2.1.3 TRACKING RECEIVERS. A setup procedure was written for adjusting:

(1) Line lengths to the tracking receivers

(2) Phase shift controls on the 4.5-mc distribution module

(3) Adjustment of the product detector module.

This procedure was used for setting up the receiver after permanent cables were installed on the feed.

13.2.1.4 SIGNAL GENERATORS. Operational. No installation/checkout activity.

13.2.1.5 COMMAND TRANSMISSION SYSTEM. On Friday, we were able to determine that the modified portion of the command antenna was due to arrive at

Eielson AFB Sunday Morning, 8 March. It will be delivered to the site Monday. In the meantime, we were informed, also on Friday, that the Rosman command antenna had again failed structurally, and that further modification will be necessary.

13.2.1.6 ANTENNA FEED SYSTEM. In the re-run of the 136-mc gains, performed Saturday, 29 February, the overall average gains differed by 1.1 db from the figures previously obtained. Data obtained Saturday is given below. The values, in db, are referenced to an isotropic source.

TRANSMIT POLARIZATION	PORT	RECEIVE POLARIZATION RHC	LHC	L-1	L-2
L-1	Sum I	31.2	28.2	27.7	
L-1	Sum II	28.2	28.7	28.2	
L-1	Diversity	28.7	26.2		28.2
L-2	Sum I	28.7	28.2		29.2
L-2	Sum II	29.2	29.2		29.2
L-2	Diversity	28.7	29.7	29.2	

Average Gain, L-1	28.30 db
Average Gain, L-2	29.07 db
Overall Average	28.68 db

13.2.1.7 SERVOSYSTEM. System checkout is complete and the system was turned over to Ted Hart for overall system testing.

While making star shots the night of Tuesday, 3 March, X-axis brakes failed to release shortly before midnight. A bad leak was discovered in the vicinity of the brake package sight glass. It was deemed impracticable to try to get RCA personnel at that hour of the night, so Bob Bamble was called out to the site from Fairbanks. Sight glass gaskits were found to be leaking. New gaskets were cut and installed, with the antenna again in business around 0100 Wednesday and star shots resumed.

There are other problems affecting both brake packages, such as gas leaks, bad solenoid, etc., which could affect antenna operation but will not if constant maintenance is practiced.

The gear reducer shaft on the Y Clark Box broke during the week, with the cause not determinable. RCA has ordered a new unit. The antenna, with the exercise of caution, remains operable.

13.2.1.8 DATA SYSTEM. The data system remains operational, and has been used all week for system testing. For the past several weeks time has been spent with the RCA data engineer for OJT purposes.

A discrepancy was noted between the data system and the servo control console. The servo console is wired up to select three receivers in this order:

(1) Receiver No. 1 -- 136 mc

(2) Receiver No. 2 -- 400 mc

(3) Receiver No. 3 -- 1700 mc.

The data system, in its present state, can handle only two conditions to display and print out in the data quality word: receivers 1 or 2, or 136 and 400 mc. At Gilmore, only 136 and 1700 mc are presently used, and the data system gives the same indication for both of these (No. 1 and No. 3) receivers. To solve this problem, a jumper was put between terminals 35 and 33 of the servo control console terminal board. If a third receiver frequency is added, a modification will be needed (as the 1700-mc modulator was required at Rosman) and then the jumper must be removed.

13.2.1.9 COLLIMATION SYSTEM. Operational.

13.2.1.10 COMMUNICATION FACILITIES. Operational.

13.2.1.11 OPTICAL SYSTEM, INTRASITE CABLING, AND STATION INTERFACE. Optical system operational. Miscellaneous and cleanup work, tagging cables, etc., in cabling area.

13.2.1.12 235-MC ADDITION AND R-F PATCH PANEL. Received (GFE) one Nems-Clarke Solid State Multicoupler SSM-101-35-242, one Aerospace Research 136-MC Line Amplifier Model LA-136, and a Nems-Clarke Dual Power Supply DPS-101 for 235-mc line drives to Ulaska. All above units were installed.

13.2.2 PROGRESS SUMMARY, 8 THROUGH 14 MARCH 1964.

13.2.2.1 GENERAL. Colder weather continued throughout the week, with the Fairbanks winter low of -46° being recorded the night of 14 March.

Nine of the twelve modified coaxial switches expected from TRW actually arrived last week. Three of the modified switches had failed to pass factory tests and will be shipped later. Since system testing was nearly complete with the exception of satellite and aircraft tracks the antenna was tied up Monday and part of Tuesday for changeover of the 136-mc switches and installation of permanent cabling for them.

Tracking of Tiros VIII, attempting Wednesday during the day, was not very successful. On the first pass there was a strong interfering signal right on 136.23 mc. This was found, after the pass was complete, to be coming from a signal generator in the Nimbus room. The next pass was going well until the antenna was driven into prelimit and then dead limit after the pass was about 2/3 complete. Tapes were obtained for two Tiros VII passes Wednesday evening; both passes were tracked with good results. Tiros VIII tracking was resumed Thursday morning. The first available pass was fairly low and was tracked only so Nimbus could try for APT; naturally the bird's APT was not turned on. No drive tape was available, so the satellite was acquired from scan and through telephone coordination with Ulaska. The next pass, with no drive tape available, was acquired from scan and successfully tracked. The following pass, with a drive tape available for acquisition, was also successfully tracked, thus completing the satellite tracking portion of Collins system testing.

For some time a strong interfering signal, not exactly on 136.23 mc but quite close to it, had been noted. This has been determined to be coming from the direction of Ulaska. Ulaska also sees this signal, but the source has defied identification.

Star shots were hampered by adverse weather conditions, but by the night of Friday 13/Saturday 14 they had also been completed, leaving only aircraft tracks remaining for completion of Collins system testing.

The calibration aircraft arrived in Fairbanks the night of Thursday 12/Friday 13. A meeting was held around noon Friday, with Site Director, Mel Clark, John Berbert and Bill McCottrey of NASA, members of the Bendix aircraft operating crew, Collins personnel, and RCA personnel in attendance. The requirements of Gilmore, Minitrack, and Ulaska for aircraft time were explained by John Berbert. John also outlined NASA's aircraft track and star shot requirements for Gilmore. These requirements differ considerably from the Collins system testing requirements. Ted Hart detailed the different flight patterns that he wanted to have the aircraft follow for Gilmore tracking on Collins tests. We were informed that the aircraft would fly that same day for us, arriving over the station at 1500 and remaining until 1800. Minitrack will be flown at night. The aircraft would be over the station at 1300 daily thereafter unless we were notified otherwise.

The aircraft arrived over the station around 1530. First attempts at 136 mc tracking with the aircraft using the forward-mounted Collins antenna were not too successful, due to prop modulation on the signal. The aircraft switching to another transmitting antenna resulted in satisfactory tracking and data collection which were continued until after 1800 when the aircraft made an emergency landing at Fairbanks International due to a fire on board.

The problem was found to be a burned-out inverter. Repairs were made Saturday and the aircraft was over the station around 1530 for 136-mc tracking. Promptly at 1800, it left to work Minitrack.

On Friday, it was discovered that there was serious trouble in the parametric amplifier system, and by Saturday night it had still not been possible to carry trouble-shooting out to a logical conclusion. Some very successful tracking was done at 1700 mc on Saturday without pump on, but it was desired to have the paramp working properly when tracking for data collection purposes.

Bill Hocking, NASA data engineer, arrived on site Friday for the purpose of checkout out and "buying" the data system.

Ted Hart spent considerable time with John Berbert and Bill McCottrey on star shots for NASA.

We have for some time been shooting for a 21 March completion date for installation and checkout. Early in the week it appeared that, barring unforeseen circumstances, this date should be good. Actual appearance of the calibration aircraft strengthened this belief. All team members, with the exception of Frank Fredrickson and Earl Pillard, have been advised to be prepared to leave Fairbanks on or about this date. Frank will leave as soon as Bill Hocking is satisfied that the data system is acceptable. Earl Pillard will be remaining in Fairbanks finishing up a few items on Gilmore and preparing for the Ulaska hydraulic drive modification supposed to begin around the first of May. Earl will finish up the Gilmore Y axis hydraulic modifications which have been held up by a lack of Vickers-supplied materials and antenna time, and will complete cable tagging. Unless the remaining three modified coax switches are received from TRW before the balance of the team leaves, Earl will also install the modified 400 mc switches and their permanent cabling.

13.2.2.2 R-F ENGINEERING.

(1) Parametric Amplifier System:

Loss of gain in all channels was discovered Friday. In an effort to make a quick fix so that the paramp would be available for aircraft tracking Saturday afternoon, the klystron power supply was removed from the electronics cage and taken into the operations room for trouble-shooting. The transformer was found to have been leaking oil and was cleaned up. The beam supply was adjusted, and the power supply reinstalled Saturday morning. Proper operation could still not be obtained.

After aircraft tracking was through Saturday night the paramp and klystron power supply were taken from the antenna into the operations room, and Les Collins came back out to the site from Fairbanks to fight the problem.

(2) Noise Figure Measuring System:

Negative readings of noise factor were corrected by installing a four-foot length of RG-58 in the noise source output.

(3) Telemetry Receivers:

A failure in the S/N 2 receiver was traced to a loose miniature coaxial plug.

All receivers were set to give equal indications for a typical input signal level (-60 dbm). There is considerable drift in the agc level, so that parity is not always obtained.

13.2.2.3 TRACKING RECEIVERS. Seven new crystals obtained from IT&T were installed in the tracking receivers to replace those that were not operating properly. After the ovens were up to temperature the frequencies of the individual crystals were adjusted; all of the new crystals operated normally.

Both receivers have been periodically checked for proper operation, and some minor adjustments have been made.

13.2.2.4 SIGNAL GENERATORS. Operational.

13.2.2.5 COMMAND TRANSMISSION SYSTEM. We were informed on Monday that the additional modification to the command antenna was to have a new base section fabricated locally out of steel. By the end of the week the new section had been fabricated and painted; the modified antenna was assembled with the exception of the nylon guys.

The polarization switching box was installed some time ago.

13.2.2.6 ANTENNA FEED SYSTEM. Modified TRW coaxial switches for 136 mc were installed Monday and Tuesday. All work on the feed system is complete with the exception of the installation of modified switches in the 400 mc system. Three more modified switches must be received before this can be done.

13.2.2.7 SERVO SYSTEM. The electronic portion of the servo drive system continues to function properly.

The new solenoid pump valve, to eliminate the small check valves and swivel fittings at the manifold, was installed on the X unit.

13.2.2.8 DATA SYSTEM The data system remains operational. The only maintenance required during the week was tightening of the drag brake on M1 to improve the performance of the Digitronics tape handler.

Bill Hocking of NASA arrived on site Friday and began acceptance testing of the data system.

13.2.2.9 COLLIMATION SYSTEM. Operational.

13.2.2.10 COMMUNICATION FACILITIES. Operational.

13.2.2.11 OPTICAL SYSTEM, INTRASITE CABLING AND STATION INTERFACE. Optical system operational. Miscellaneous and cleanup work, tagging cables, etc. in cabling area. The five telemetry receivers were bolted securely to the floor, using 2-inch angle iron for the backup plate, since the equipment is all mounted on pull-out drawers and the receivers are very top-heavy.

13.2.2.12 235-MC ADDITION AND R-F PATCH PANEL. We were informed that the 235-mc addition, as far as we are concerned, will go in as originally conceived. The additional units desired by the Site Director cannot be obtained GFE before our scheduled departure.

We were also informed that we would be responsible for the r-f patch panel installation if the GFE portions arried in time to permit installation before our departure.

A five-foot length of 3- by 3-inch plastic cable duct was installed in the r-f patch panel rack preparatory to cabling in case the patch panels themselves should arrive in time.

13.2.3 FINAL PROGRESS REPORT, 15 THROUGH 28 MARCH 1964.

13.2.3.1 GENERAL. Fairbanks weather remained very cold during the first week of the reporting period, with a low of -41° and high of -11° on Monday. Over the weekend, a warming trend commenced. During the last week, daytime temperatures occasionally approached the melting point although nighttime readings remained for the most part well below zero.

Alaska celebrated the Collins crew's imminent departure with a destructive earthquake around 1730 Friday, 27 March. Damage was confined mainly to coastal and offshore areas; Fairbanks and the site escaped with no more than a lengthy (over 10 minutes of tremors) and admittedly a little scary shaking up.

The paramp was back in operation by the time the aircraft was able to get off the ground and over the station Sunday afternoon, 15 March, around 1700. Very little could be accomplished as the aircraft was unable to stay airborne, due to a serious oil leak, and went back in. The airplane has been plagued by a number of major and minor problems resulting in very little flight time available for us.

Bob Wigand and Jim Johnson arrived on site Monday. The aircraft did not fly at all that day, the oil leak problem apparently being complicated by the extreme cold.

A meeting was held Tuesday morning between Bob Wigand, Mel Clark, and Bill Hocking of NASA, and Jim Johnson, Ted Hart and Jake Rose of Collins. Items remaining to be completed were reviewed and the need for more aircraft time was emphasized. Bill Hocking expressed his desire to get the predict, drive, and record tapes on a couple of satellite tracks. Bob Wigand informed us that NASA r-f engineer Gene Humphries would be in Wednesday night for acceptance checking of the r-f subsystems.

The airplane was to have been over the station between 1200 and 1230 hours on Tuesday; it actually was overhead around 1330. The 235-mc dipoles had been removed from the feed assembly so that Ted Hart could see if their removal would have any effect on the boresight shift; it did not. The aircraft stayed with us for two hours and then had to go back in with trouble.

Ted, Jim Johnson, Bill Hocking, and Bob Gamble remained at the site late Tuesday to get a couple of Tiros VII passes and do some star work for John Berbert. Problems were encountered in the 136-mc system, and nothing was accomplished. After considerable troubleshooting Wednesday it was discovered that one of the recently installed modified coaxial switches was switching backward. (It was later corrected on site.) The switch was replaced and normal 136-mc operation obtained prior to arrival overhead of the aircraft at around 1845. Tracking was exceptionally good, and by the time the aircraft was forced to go back in a little after 2100, Ted had collected enough data to complete the Collins system test requirements.

Bill Hocking departed Fairbanks Wednesday night, and Frank Fredrickson left Thursday night.

Gene Humphries came in Thursday morning and started checking r-f systems. John Berbert advised us of his desire for aircraft tracking tomorrow; two each 2-hour period (in its present condition the aircraft can fly for only 2 hours at a time) Friday, one period on 136 mc and one on 1700 mc. Tracking is to be performed by both Gilmore and Ulaska, with the aircraft flying circular patterns at 25°, 45° and 65°, plus a few crosses.

A meeting was held at 1400 Thursday between Bob Wigand, Mel Clark, and Gene Humphries of NASA, Jim Johnson, Ted Hart and Jake Rose of Collins, and Phil Hendricks of RCA. It was agreed that RCA personnel would work overtime that night to grind down areas around the Y bearings which were interfering after prelimit angles were exceeded, thus permitting final setting of Y dead and prelimits. Gene Humphries indicated his satisfaction so far with the signal generators, multicouplers, command transmitter, and the 1700-mc system including paramp. He was also satisfied with the telemetry receivers, but wanted to see a Nimbus loop test with tape to see if certain telemetry problems encountered at Rosman could be confirmed. He also wanted to see the command antenna loaded, wanted 1 or 2 hours on the collimation tower, and wanted a check of the 235-mc system through to Ulaska. In addition, the threshold sensitivity of the 136-mc receiver had been found low.

Joe Day worked until 2300 Thursday night on the 136-mc receiver and found the trouble to be a broken wire in the i-f adder module.

Thursday night and Friday all floor panels were removed and the subfloor was completely vacuumed.

Friday the 136-mc system started acting up again. The coaxial switches were suspect and Ted Hart changed out the modified ones for the old ones, while Joe Day was troubleshooting the phase detector module in the receiver itself. Joe had been all set to leave Fairbanks on Alaska Airlines that night with his family, but with this development it was necessary for him to remain behind while they went on to Seattle to await his arrival. Joe Beaver, Bob Gamble and Ron Mason were also scheduled to leave that night; since work in their areas was either complete or had been scheduled for completion by others. They departed as planned.

Saturday Joe found a malfunctioning transformer in the phase detector module. Jim Johnson requested a replacement module from ITTFL, to be shipped on an urgent basis. In the meantime the transformer repaired itself but it was decided to change out modules, regardless, with the replacement module arrived, as it was believed that the old one could not be completely relied upon. This was eventually accomplished before our departure.

Also on Saturday, Les Collins successfully loaded the command antenna for Gene Humphries.

With the phase detector module repaired and the 136-mc receiver apparently operating normally, it was still found to be impossible to set up the receiver for tracking, using the collimation tower(s). The receiver was still suspect, so it was rechecked thoroughly and was finally used in the 1700-mc system, establishing that the receiver itself was operating satisfactorily. Investigation was then centered on the feed system.

Les Collins and Ben Hong had planned to leave Sunday, 22 March, but in view of the work load involved in troubleshooting the 136-mc system, it was agreed that they would stay on.

On Monday the calibration aircraft was airborne again at 1600, flying for Ulaska and scheduled to leave Fairbanks early Tuesday morning. We had previously completed 1700-mc aircraft tracking for John Berbert but were never able to get set up for 136 mc.

A meeting was held at 0930 Tuesday between Bob Wigand, Mel Clark, Gene Humphries, Jim Johnson, Ted Hart, and Jake Rose, to assess the situation and determine a course of action. The calibration aircraft is due back around the end of April; Gene Humphries will return at that time to observe 136-mc aircraft tracking and switching from 136 to 1700 mc, and vice-versa. The extent of Collins participation in these tests remains to be determined; it was agreed that RCA personnel could reasonably be expected to operate the equipment at that time. It was also determined that if the 136-mc trouble had not been pinpointed by noon, outside assistance would be summoned.

The 235-mc loop test was successfully accomplished for Gene Humphries Tuesday afternoon, as far as Collins installation work was concerned. Gene departed Fairbanks that evening.

After the 136-mc receiver had been proved to be operating properly, the antenna feed system was subjected to exhaustive and detailed tests and visual examination over a period of several days. By Tuesday noon, 24 March, site personnel had not been able to find a thing wrong with the system - except that it was still not possible to set up properly on either collimation tower. At this point Jim Johnson called Dallas and was informed that Bert Reynolds, Collins r-f engineer, would arrive in Fairbanks Wednesday, 25 March, to give us a hand and the benefit of a fresh point of view.

Also on Wednesday the Y limits were reset, since the interference problem around the bearings had been eliminated. Bob Gamble had already set the normal X dead limits at -90° and +89°, with prelimits at -88° and +87°. Obstacle avoidance dead limits had been set at ±82°, and prelimits at ±80°. Bob had left word with RCA personnel to set normal Y dead limits at ±80° and prelimits at ±78°. Obstacle avoidance dead limits were to be +78° and prelimits +76°. A good portion of the day was spent in resetting Y limits (RCA personnel actually did the setting) and in running interference (limit switch performance) checks for Bob Wigand. Bob departed Fairbanks Wednesday evening.

Also on Wednesday, after discussion of the matter with Site Director, Mel Clark, it was decided to change the klystron in the paramp, so the paramp and klystron power supply were again removed and Les went to work.

Bert Reynolds arrived Wednesday night. Thursday morning, after discussion of the problem among Bert, Ted Hart and Joe Day, and after rechecking the symptoms, it was concluded that the problem was most likely to be propagation from the collimation towers, with ground reflections the cause. This belief was confirmed by using the sun as a collimation source, and finding that the system was in fact performing correctly and, using the sun, could be easily adjusted for optimum tracking performance. One very low pass of Tiros VII was then successfully tracked, as were several passes of Tiros VII.

With the problem solved it was decided that Jim Johnson, Ted Hart, Bert Reynolds, and Ben Hong would leave Friday night, and that Les Collins and Jake Rose would leave Saturday as soon as final check and adjustment of the paramp was accomplished and final shipment of tools and equipment was made.

A meeting Friday morning of Collins personnel with NASA Site Director Mel Clark and local RCA management basically confirmed what was agreed in the Tuesday, 24 March, meeting of NASA and Collins representatives. RCA will take over operation and maintenance of the several subsystems, with the provision that no modifications or maintenance in depth be performed on the 136-mc tracking system until the aircraft tracking capabilities of that system have been redemonstrated to NASA upon return of the calibration aircraft, and after the system has been accepted by NASA. RCA personnel will operate the system during the demonstration, which will be observed by at least one Collins representative.

Earl Pillard will remain on site to complete hydraulic modifications on the Y axis and install the modified coaxial switches in the 400-mc system when the three additional switches are received from TRW.

RCA personnel noted for the record several equipment discrepancies claimed to have been observed:

(1) Synchro slippage on both axes in manual position.

(2) Erratic agc in GD T/M Receiver #3.

(3) Leaky transformer in klystron power supply.

(4) Very large discrepancy existing in 136-mc boresight.

On item 3, Collins is ordering a new transformer so that RCA may replace the one which is leaking.

Ted Hart has written a new receiver alignment procedure for 136 mc, has demonstrated the procedure to RCA personnel and left copies with them, and demonstrated satisfactory satellite track to them after alignment procedure was followed.

In the process of troubleshooting the 136-mc feed system, several of the coaxial switches had been changed back to the modified type. After the system was found to have been OK from the start, the 136-mc switches were all changed back to the modified type. The 235-mc dipoles were also reinstalled and cabled up.

Collins personnel scheduled to leave Friday night did so. Les Collins, Jake Rose, and Earl Pillard were at the site Saturday morning to complete checking of the paramp and for final cleanup, packing and shipping. Jake got away from Fairbanks, driving, at 1445, and Les flew out on Alaska Airlines Saturday night.

13.2.3.2 R-F ENGINEERING. Troubleshooting of the paramp the night of Saturday 14/Sunday 15 March showed loss of gain in all channels was due to the klystron having drifted off frequency. Mechanical retuning to 9.45 gc restored the gains to within specification although considerably lower than they had been previously. RCA was advised that the klystron was aging and might need replacement in the future.

The temporary thermostat and relay were removed and replaced with new components and the paramp and power supply were reinstalled. Operation resulted in a high-temperature warning. This was found due to maladjustment, which was corrected. The paramp box is now maintained at 90°F with high temperature warning at 100°F. The high temperature cutoff in the klystron power supply unit was damaged during adjustment; a replacement was ordered and eventually given to RCA for installation when convenient.

On Wednesday, 25 March, after the paramp had performed well during tracking and had been accepted by Gene Humphries, it was working quite well at the time the klystron would be changed out in order to avoid any possible future complications. This was accomplished and pump filters were retuned. All channel gains were then found to be back around where they were originally. Les Collins made a final check of the system the morning of Saturday, 27 March.

13.2.3.3 TRACKING RECEIVERS. Work done on the tracking receivers during this period has already been detailed in paragraph 13.2.3.1. The receivers are both functioning normally. The 1700-mc receiver has been accepted; the 136-mc receiver will not be accepted until after redemonstration.

13.2.3.4 SIGNAL GENERATORS. Operation and accepted.

13.2.3.5 COMMAND TRANSMISSION SYSTEM. Assembly of the modified command antenna was completed Monday 16/Tuesday 17 and vswr measurements were made. Earl and Jim Johnson installed the antenna Wednesday. Cabling up of the antenna and polarization switching box was completed and, after Gene Humphries' arrival, the performance of the system was demonstrated to his satisfaction.

The modified antenna appeared to be very stable.

13.2.3.6 ANTENNA FEED SYSTEM. The 1700-mc feed system has been accepted. The 136-mc system was checked and tested thoroughly during this period, and has been determined to be operating properly; however, the system will not be accepted until after redemonstration.

400-mc coaxial switches remain to be changed out.

13.2.3.7 SERVO SYSTEM. Y yoke pot modification was made during this period. X hydraulic modifications were complete to date; some of the Y hydraulic modifications are to be completed by Earl Pillard during the coming month.

Operation of the servo system is normal and has been accepted.

13.2.3.8 DATA SYSTEM. Operational and accepted.

13.2.3.9 COLLIMATION SYSTEM. Operational and accepted.

13.2.3.10 COMMUNICATION FACILITIES. Operation and accepted.

13.2.3.11 OPTICAL SYSTEM, INTRASITE CABLING AND STATION INTERFACE. Optical System operational and accepted. Final cabling and cleanup accomplished; a few cable tags remain to be installed by Earl.

13.2.3.12 235-MC ADDITION AND R-F PATCH PANEL. Final items for the 235-mc addition were received, installed and cabled up. Satisfactory performance was demonstrated to Gene Humphries.

The GFE r-f patch panel had not arrived by the time of our departure.

13.3 SYSTEM TESTS.

13.3.1 SYSTEM TEST AT FAIRBANKS.

During the period 2 March to 26 March, complete system tests were conducted at the Gilmore installation. A complete and formal report of these tests is not being compiled and will be submitted at a later date.

Mr. Ted Hart, who directed the system test at Gilmore, submitted a summary of the tests conducted in the form of a trip report. This trip report is included here in its entirety.

13.3.2 SYSTEM TEST - FAIRBANKS NO. 2.

The following information relates the activities during the system test period at the Gilmore Tracking Station. The system tests performed during that period are those which shall be analyzed for the final report. The analysis of the data is underway and will be completed in the near future.

During the period of 2 to 13 March 1964 the following tests were performed and their purpose is briefly detailed as follows:

(1) An optical boresite test was performed to determine antenna encoder system backlash and to obtain a true position of the collimation antenna by averaging the data.

(2) An r-f boresite test was performed to determine the relationship between the optical and r-f axis and to determine the parameters that might exist during system operation that affect a change in this relationship. This includes a test which measured boresite shift with polarization of the collimation source.

(3) The receiver analog error signals were measured as a check on the proper operation of the receiver and antenna feed system and to determine factors that affect tracking performance.

(4) Acquisition characteristics of the tracking loop were measured using the collimation source to determine the overall tracking loop performance.

(5) Three separate groups of star shots were taken to determine both the calibration of the encoder system and the properties of the antenna structure including alignment and mechanical deflection characteristics.

(6) The dynamic characteristics of the tracking loop were determined at low velocities and zero velocity by tracking the sun over a several hour period, a radio star over a 25-hour period, and the collimation tower source for a 24-hour period. For higher antenna velocities, several passes of Tiros VII and Tiros VIII were tracked.

(7) The Optical Horizon was measured during this period.

Aircraft tracks started on 13 March and included a total of 67 overhead passes during the period of 13 March through 18 March. Approximately one-half the passes were on 136 mc with the other half on 1700 mc.

Only a portion of the data from these tests has been reduced to date. However, the system operated satisfactorily during the test period with minor exceptions. Preliminary reduction of the Star Shot information has revealed no significant errors in system alignment. A misalignment of approximately 0.2 degrees was exhibited during the aircraft tracks between the 136-mc r-f system and the optical system. The misalignment between the optical system and the 1700-mc r-f system was less than 0.05°. The system would readily switch from 136 to 1700 mc without loss of track on the aircraft. Both the servo and the program system operated satisfactorily during the test period with the exception that at high antenna velocities an error existed between the actual and program positions. Program tapes were checked on stars and produced high accuracy pointing information. The receiver systems operated satisfactorily during the test prior to 20 March, at which time a transformer failed in the 136-mc receiver. A klystron was replaced in the 1700-mc parametric amplifier at the end of the test program to insure continuing performance of that system.

When the 136-mc receiver failed, several days were spent restoring the receiver and overall tracking loop to proper operation. After the fault in the receiver was repaired, it was determined that proper system operation could not be achieved utilizing the collimation source. This was exhibited through not being able to properly determine the correct adjustment for the phase and amplitude controls associated with the receiver error signals using established procedures. Through substitution methods using the basic 1700-mc receiver for a standard of comparison, the 136-mc receiver was proved to be operating satisfactorily and it was determined that a problem existed in the antenna system at 136-mc. Exhaustive tests of the antenna system, including pattern measurements, vswr measurements, and continuity and loss measurements failed to reveal any discrepancy in the feed components or the system as a unit.

Further tracking loop measurements were made using the sun as a collimation source. These tests revealed that the entire tracking loop system was performing correctly and could readily be adjusted to obtain optimum performance only when the collimation source used for alignment and test was above the horizon by approximately two antenna beamwidths (about 20°). At lower elevation angles, ground reflections induce undesired signals in such a manner as to prevent proper alignment and operation. Similar effects are present for the 1700 mc system but are negligible at the standard collimation tower elevation angles due to the narrow beamwidths of the antenna at this frequency.

As a further check, several satellite passes were tracked. These passes took place on 27 March. The pass covering the highest elevation angle at the point of closest approach was acquired near the horizon and tracked continuously through the orbit until it passed below the optical horizon for the Gilmore site. Both open-loop and closed-loop receiver conditions were tried during the pass and the overall tracking accuracy of the system was very good, being degraded slightly for narrow receiver bandwidths due to the type of modulation on the satellite's tracking beacon.

After having established that the system was operating properly, a new receiver alignment procedure was written to enable the operating personnel at the site to properly adjust the system for optimum performance. This procedure was demonstrated to the personnel and was followed by tracking a satellite to emphasize the performance characteristics of the system when aligned in the prescribed manner. A copy of the data from this pass has been forwarded to GSFC.

COLLINS